

V.V. Rodionov and I.A. Shabarshov

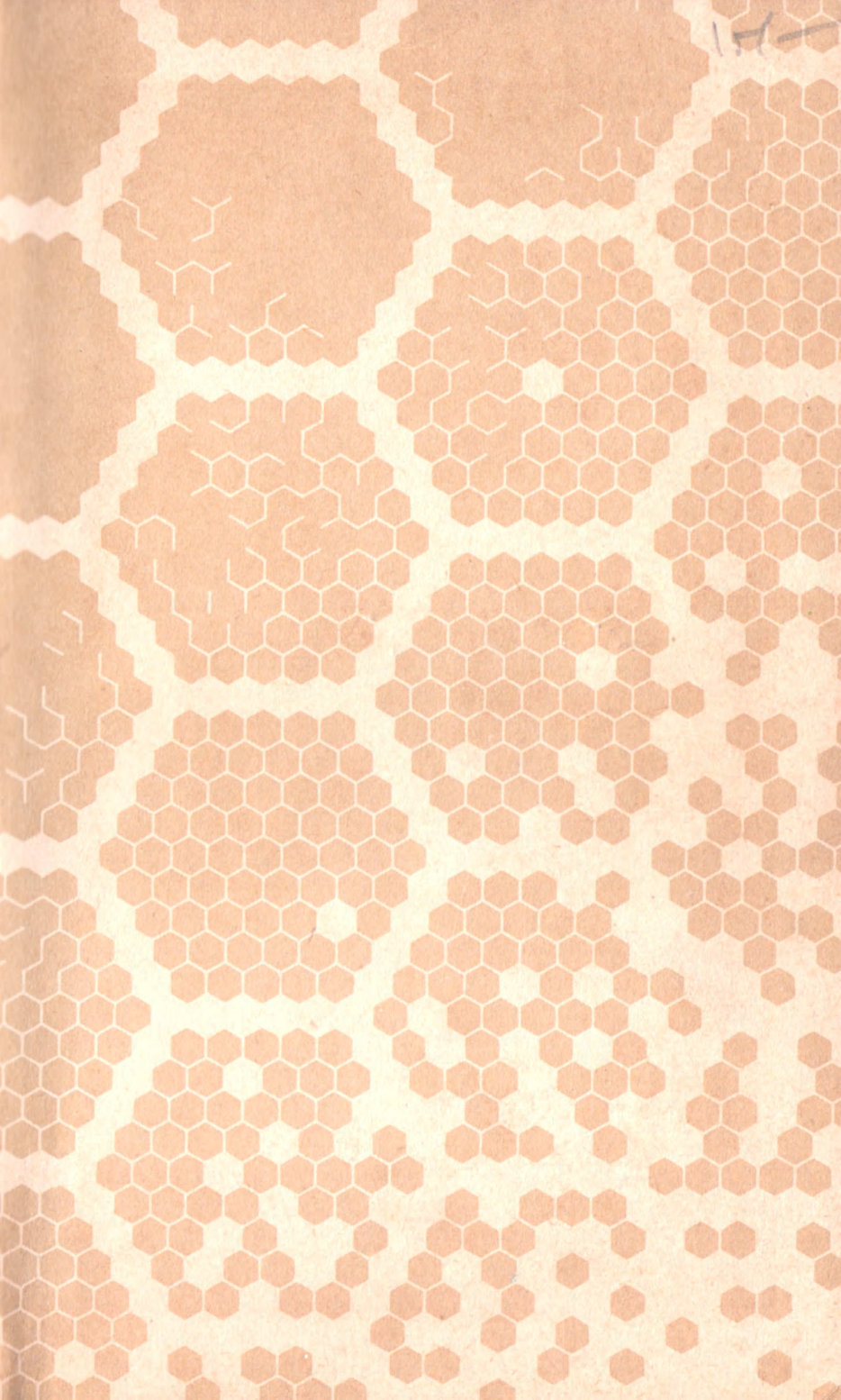
The Fascinating
World of

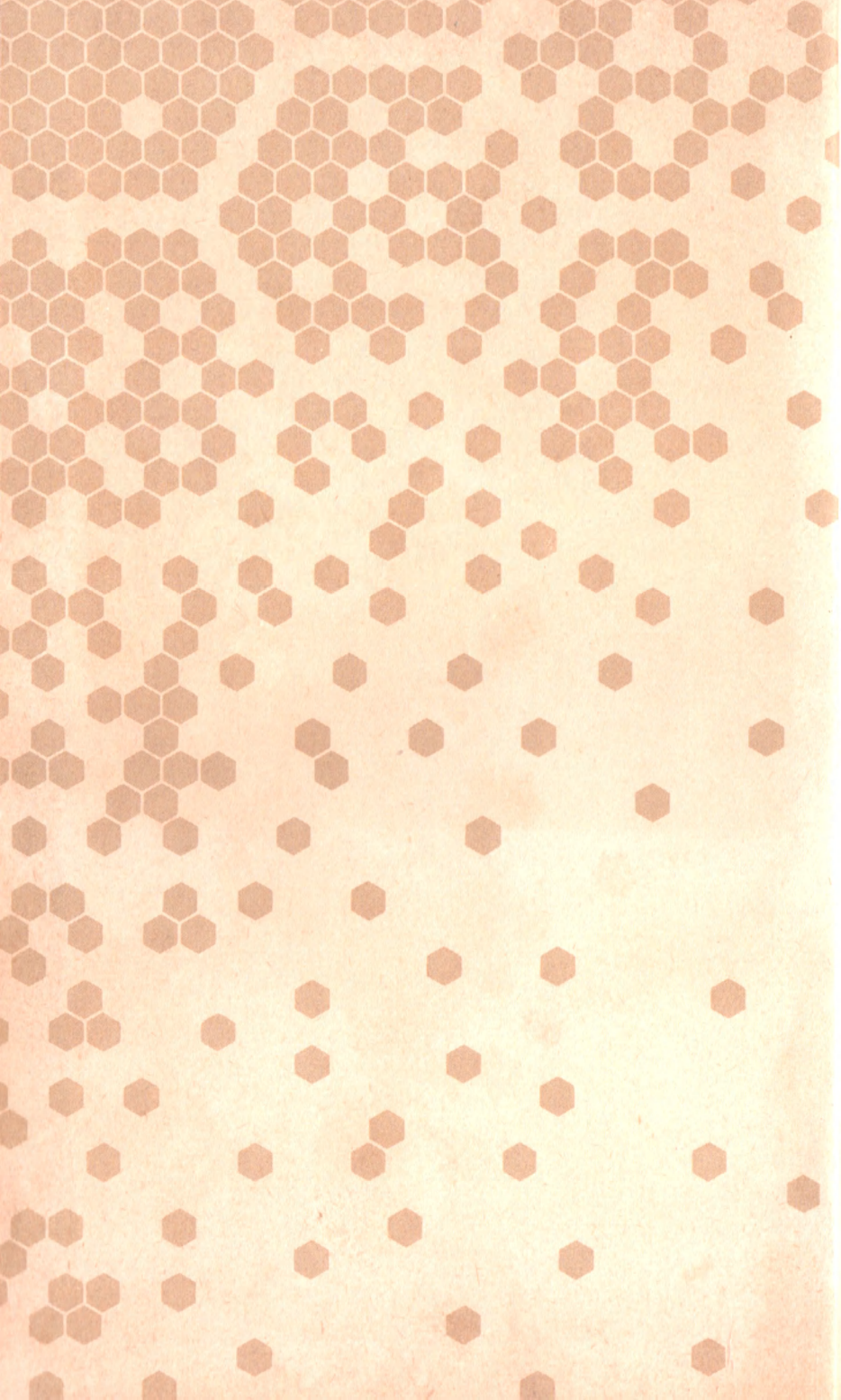
BEEES



Mir Publishers Moscow







The Fascinating
World of
Bees

В. В. Родионов, И. А. Шабаршов

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«Колос» Москва

V.V.Rodionov and I.A.Shabarshov

The Fascinating
World of
BEEES

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What Is This Book About?



The answer to this question is very simple: it is about honeybees and beekeeping, about the instincts governing the activity of a bee colony at different stages of its development, about the ways to master these instincts and how to use them in practical beekeeping.

The life of bees is extremely interesting and very instructive. People have been dealing with these insects for many millennia. And wherever one lives, be that in a quiet little village or a large noisy city, if one loves nature and can appreciate its beauty, these wonderful and amazing insects will by all means enchant you. If you by chance happen to be amidst a fruit garden in spring, or in old linden park in summer, or in some flowering meadow in full bloom, or likewise in the edge of a wood, do look at the flowers, at least for a short minute, to enjoy thoroughly the wide variety of their colours and forms. You are sure to see bees flying from flower to flower, to hear the monotonous buzzing of these never-tiring toilers.

When a bee is collecting nectar (the sugar juice of plants which is the bees' main source of carbohydrates) or pollen (their fund of protein and vitamins), hundreds of thousands of pollen grains that are male gametes of plants stick to the bee's body, thickly covered by little hairs. Upon landing on a new flower of the same species or even of another one, the bee not only gathers pollen from this flower but she simultaneously deposits on it some pollen from another blossom. In this way, flying from flower to flower, bees pollinate them, promoting the richest setting and high quality of fruits.

Thousands of additional tons of buckwheat grain, sunflower seeds, fruits and berries are obtained thanks to bees working in gardens and fields during the time when these crops are in bloom.

It is not accidental that bees are regarded as reliable assistants to agronomists. Bees render us their invaluable aid in improving the strains of fruit, berry, oil and groats crops, as well as in the breeding of new high-yield hybrids. In view of this, we have every reason to view

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Flowers in the Tien Shan Mountains.

bees as winged selectionists. For it is first and foremost the insect-pollinators, including the honeybee, that we owe for the infinite variety of higher flowering plants decorating our planet. The constant links and interrelations between bees and the floral kingdom were undoubtedly responsible for the preservation, improvement and perfection of early flowering forms during their evolution, as well as for the appearance of many new ones. It is impossible to imagine the floral kingdom without bees—the pearls of nature.

The bee gives man honey, the liquid gold of nature, a product incomparable to anything else in terms of its nourishment and healing properties. In ancient times, honey was thought to be a great gift of the gods, who miraculously sent it to Earth for the benefit and happiness of human beings. Both kings and common ordinary people used honey for healing purposes, as it was believed to be a universal reme-

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On blooming buckwheat.

dy for many diseases. A very old manuscript of a Russian medical book reads as follows: "Honey is the juice from heavenly dew which the bees collect during a good time from flowers that smell so sweet; that is why it possesses such great power and can be of tremendous medicinal use in the treatment of many maladies." Honey has a favourable effect upon the human organism, strengthening it and prolonging man's life.

All over ancient Rus', which was so widely inhabited by bees, honey was used in brewing spirits. As chroniclers record in their old annals, at grand feasts such drinks used to be enjoyed "to a state of great intoxication". Ancient Rus', as these chroniclers claim, smelled of honey. Honey was one of the first items traded by Rus' with other countries.

Man got to know the taste and usefulness of honey in distant an-

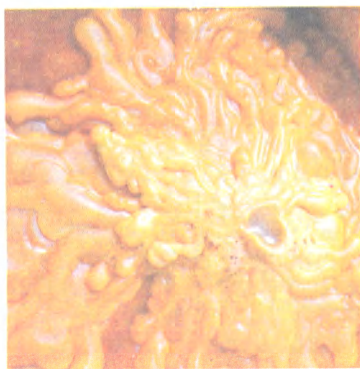
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A garden apiary.

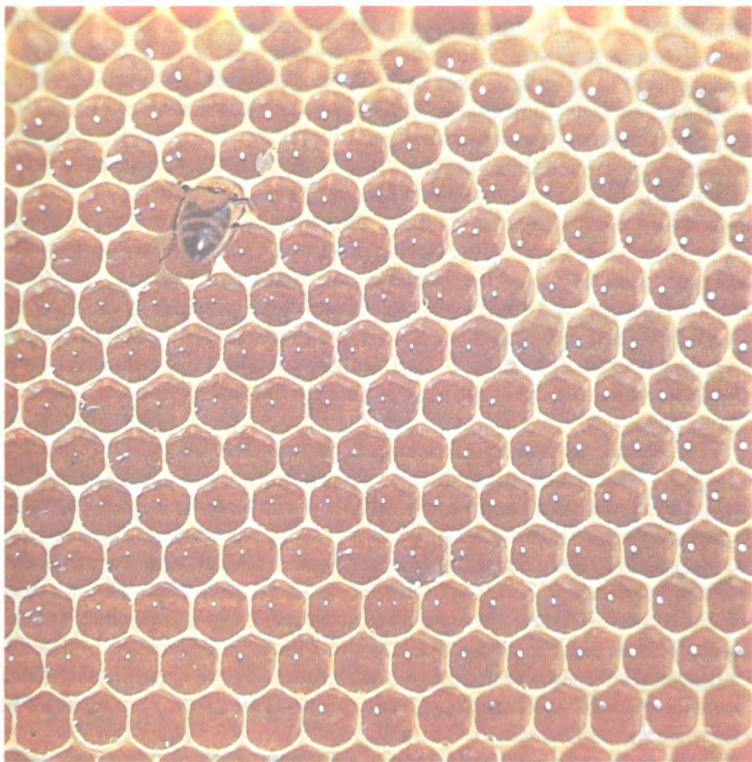


A spring pollen plant.



The wax dropper.

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Fresh honey.



*The commercial nectar plant of the main
honey flow.*



Collecting pollen.

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cient times. Having once discovered by accident the honey of wild bees living in the forests, man began to search actively for it, and this activity soon formed the basis of a very important trade and occupation, second only to hunting. Entire forest settlements were often engaged exclusively in providing honey. Up to the present day, the names of such settlements speak for themselves, for instance, Bortnoye, Bortitsy, Troebortnoye, Medyn', Pchelinovka*.

With time man began to protect wild bees and, by and by, he started to breed them specially. Beekeeping was more and more encouraged and special laws were passed to safeguard this trade, particularly during the time when honey was the sole sugar product in man's diet. During the last two centuries, apiculture has been a favourite occupation and hobby of millions of people. In our time it has become an important branch of agriculture, a genuinely industrial and commercial endeavour.

The second valuable and essential product derived from honeybees is wax. This organic substance possesses unique properties found in no other elements of nature, and it can preserve its qualities for hundreds of years. In the distant past, beeswax functioned as currency, serving as the reference standard in commodity exchange on the international market. If honey is justifiably called liquid gold, the wax may be called gold bullions. Today, like honey, wax is an important export item. Wax is used in many branches of industry, especially in electrical engineering, aviation, and pharmaceuticals. There are no substitutes for wax even in aeronautics. Great quantities of wax are required in commercial apiculture for making honeycomb foundations.

Honeybees provide such unique products as propolis (bee glue), apitoxin (bee venom), pollen, chyle (royal jelly, sometimes called queen jelly). All of them contain biologically active substances and are very effective as medical cures.

Propolis, as employed for treating wounds, long-healing sores and burns, is mentioned in old folk medical books and manuscripts of different nations. Today's biochemists and physicians have discovered most effective antibacterial and antibiotic properties in propolis, owing to which it is presently widely used in treating numerous serious diseases, both external and internal.

As early as ancient times, people noticed one interesting thing: honey-hunters and wild-honey farmers did not suffer from any diseases

* In English these names mean, respectively: The Village Dealing with Keeping Wild Bee, The Settlement Engaged in Wild-Beekeeping, Three Villages Keeping Wild Bees, Honey-Scented, Bee Village.

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of the joints, their health being usually very sound. This fact was later attributed to the bee's sting to which honey-hunters and wild-honey farmers were constantly subjected. There is a folk proverb about bees: "He who is stung is the bestowed one". Modern medicine has been applying apitoxin successfully to control and treat rheumatism, cardiovascular diseases, and various disorders of the nervous system.

Truly magical are the medical and tonic effects of chyle (queen jelly) which is the super-concentrated product derived from young bees who feed it to the queen's larva. Chyle contains all the elements vitally necessary for man. Among these valuable stuffs are proteins, fats, vitamins, mineral salts, hormonal and other biologically active substances which fortify man's health and prolong his life, rejuvenating him. These substances are provided in queen jelly in such physiological quantities as the human organism requires. Queen jelly is especially recommended during a time of rehabilitation and recuperation, as well as during periods of physical and emotional stress.

The pollen collected by bees from flowers to feed their brood is known as a wonder-product. Pollen is rich in protein substances, amino acids, vitamins A, B, C, D, E, PP (the B vitamin group is the richest), hormones, antibiotics, and microelements. The latter are indispensable for human and animal organisms since without them no biochemical processes in these organisms are possible. A growth stimulant has been discovered in pollen also. It takes only one or two teaspoonfuls of pollen per day to help man improve and fortify his health after physical or nervous strains and stresses, general fatigue, and exhaustion. Pollen stimulates the appetite and regulates the functions of the digestive tract. It is used to treat liver (hepar) diseases. Pollen is of great benefit for healthy people, too, especially when they are subject to heavy physical and mental strains.

Today's modern pharmaceutical industry employs various products of the honeybee to manufacture a great number of medicinal drugs. The high efficiency of the latter and their wide use in health care initiated a new and highly promising branch of world medicine, namely, the branch of apitherapy.

The role of the bee in the life of man and the importance of beekeeping have thus become even greater.

However, it was not only the exceptionally beneficial properties of honeybees that attracted man to these creatures. People were long ago fascinated and enchanted with the bees' way of life and the faultless perfection of their instincts. When bees are at work in their hive, one can stand nearby hour after hour, admiring their skills and art.

In his association with bees, man experiences a lot of happy emotions, he feels spiritually enriched and refined; he begins to under-

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stand nature much better since his keenness of observation and his inquisitiveness are developed to their utmost as he strives to comprehend these insects' life as thoroughly as possible. To keep and take care of honeybees is one of the greatest pleasures man can enjoy. The more you get to know the bees, the more interesting it is to work with them.

"Beekeeping is of great moral benefit," writes Academician A. M. Butlerov, the founder of Russian rational apiculture. "To some extent, it is of educational value, too. To be able to succeed in beekeeping, great attention, accuracy, and a quick mind are required; and all these qualities necessitate sobriety. Everyone knows that in our nation itself it is believed that bees will have nothing to do with bad or evil people."

Johann Dzierzon, a famous Polish-German beekeeper, wrote that he who takes up beekeeping not only for the sake of material benefits, but who treats the bees with genuine love and care, observing them with his utmost attention, this man almost always proves to be a good person, a devoted and brave citizen, and a true friend.

Working on an apiary, where the air is clean and saturated with the aroma of flowers and honey, with the healthy and spicy odour of bee-bread, is beneficial for one's health, relaxing his nervous system and enhancing his physical powers. Working with bees is advantageous for everyone, and it is not accidental that beekeeping is a favourite hobby of farmers and physicians, workers and scientists, engineers and writers, retired pensioners and young schoolchildren. For some of them this hobby is a passion acquired only recently but there are some people for whom it is a kind of a cherished family tradition passed down from generation to generation. Beekeeping has actually become a profession for some people, and it often turns out to be a joy and kind of embellishment in life's later years. "Honeybees are my element, tending to them is my most favourable form of recreation. I give them all the spare time I have," this is what beekeepers usually say.

However, we have to be honest and admit openly that beekeeping is not merely a nice form of recreation or solely done for fun. Beekeeping, in the first place, is hard work which demands great efforts and heavy strains at times. Honey is not easily obtained either by the bee or by the beekeeper, it involves great pains. There is a saying that to keep bees is not as easy as lying in the shade, because talking alone will never yield any honey. But there is no denying that beekeeping is a most enjoyable, heart-warming and highly attractive occupation. This work offers, in addition to everything else, generous rewards if the beekeeper knows the theory of apiculture well and is capable of

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putting it into practice. "Generally speaking, beekeeping is such a thing", G. P. Kandratiev, a famous Russian apiculturist of the late nineteenth century wrote, "that, to be well accomplished, demands one with a genuine calling for it; without this calling, there will be no enthusiasm, no love for the bees, and I will be absolutely resolute in advising such people never to take up beekeeping under any circumstances."

Noncommercial (amateur) beekeeping, by the way, provides great advantages not only to the one engaged in it. It is of high benefit to the society as a whole. Honeybees do not understand the concept of territorial frontiers. They increase the yields of garden and orchard crops not only of the beekeeper himself but also of those owned by his neighbours, as well as of field crops on public and state farms situated within the radius of their flight, or else when these fields are specially treated with honeybees brought there for this very purpose. However, it should be mentioned that alongside their obvious public benefits, bees in one farm apiary may bring harm to another local apiary. Bees are capable of robbing the honey from hives which are not theirs, and thus they can transmit diseases from some unhealthy beehive to those which are quite hale and healthy, or, vice versa, they can accidentally bring disease-carriers onto their own hives. Epizootic diseases are rather frequent, and in such cases apiaries become profitless and can occasionally even die off.

There is another danger which at first glance seems to be more hidden. If one keeps bees of low productivity, their poor heredity will be transferred to the bee colonies of nearby noncommercial beekeepers and even to commercial apicultural farms. All these facts impose a certain great moral responsibility on beekeepers. And that is why amateur, noncommercial beekeeping is by no means an undertaking of one person alone; honestly speaking, it goes far beyond one's personal and private interests.

In the USSR, private beekeeping is widely encouraged by the state. As far back as April 1919, V. I. Lenin signed an act "On the Protection of Beekeeping". It reads to the following effect that, when exercised by the beekeeper himself or by members of his family, his beekeeping is protected by law and cannot be restricted either in terms of his apiary area or the number of his hives. The respective offices in charge of land regulation were obliged to render any aid and assistance to all organizations and individuals willing to take up honeybeekeeping, to provide them with wide opportunities to set up apiaries in the places most suitable for their purposes. This attitude continues to exist today when amateur apiculturists are permitted to have in their personal possession as many hives as necessary to meet their needs. When

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the time for harvesting honey begins, they are allowed to take their hives far into the fields and forests so as to be in the closest possible vicinity of wild and cultured nectar plants, the administration of the local agricultural farms and other offices involved having been duly informed and in full agreement with their action.

Noncommercial beekeepers gather in societies, clubs, associations. As a result of their joint efforts beekeepers find it much easier to take greater advantage of the vast opportunities presented to them, as well as to protect their bees from diseases and toxic chemicals with which plants are treated. It is also easier in this way to stay abreast of the latest achievements of modern science and technology, the most up-to-date, practical, and efficient, methods tested by advanced apiculturists. Thus, amateur beekeepers can better implement their aspirations to help solve the important tasks related to the national economy as a whole, and to apiculture, in particular.

Honeybees are wonderful creatures, indeed. They have every right to attract man's attention. Endless are the legends dedicated to bees, beautiful fairy-tales, sweet poems composed by those living in different times and in different lands! The harmonious life of a bee colony, the honeybee's extraordinary capacity and fitness for work, the breathtaking architecture and geometrical accuracy in their waxen homes, the process of their reproduction, as well as many other things in their life, have been the objects of investigation and speculation for many centuries, attracting the minds and hearts of the most outstanding naturalists, writers, and philosophers.

Ancient peoples considered the bees to be a symbol of moral purity, of social order, frugality, and efficiency. It was long ago that the secrets and mysteries of bees' colonies were revealed and the intricate interrelations between individual members of such colonies scientifically and thoroughly investigated. Ever since these discoveries were made, reliable techniques have been developed to control and govern the life within a bee colony, but despite all that there still remains a great deal that we do not yet properly comprehend. Until this very day, the bee excites the mind of the scientists, practitioners and anyone who loves nature and is capable of appreciating its beauty and perfection.

"Even though you may keep your regular visits to your bees for a hundred years in a row," N. M. Vitvitsky, one of the oldest prominent Russian apiculturists used to assert, "with every new excursion to their dwelling you will never fail to see or to hear something absolutely new which was hitherto yet unseen or unheard by you... Nature has accumulated so many wonderful things in the home of bees that there will never be an end to your surprises over these creatures."

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If, our dear reader, you are keeping bees already, or if you have only recently made up your mind to undertake this thrilling occupation, whether you work at a public or state apiary, you must have a good understanding of how bees live, so as to be able to manage them as a well-educated beekeeper should. Here, theory and practice must march hand-in-hand, supplementing and enriching each other. Beekeepers, like other specialists, are not made by textbook reading alone.

“A genuine beekeeper and master of bees,” A. M. Butlerov used to say, “is only he who has a solid knowledge of the entire life cycle of the bee and who can apply his knowledge to his practical endeavour.”

As we sincerely hope, the book which is now in your hands will be able to accomplish these tasks. In writing this book, we based ourselves on the biology of bees in order to explain, as best as possible, the physiological state of the bee colony at different stages of its evolution and, with regards to these stages, to offer the reader certain technological methods for managing the bees’ instincts and for controlling them. We tried to do our level best to substantiate the feasibility of the techniques we discuss. It is also our sincere hope that, enriched by his own personal experience and knowledge, and having creatively reconsidered his approach both in theory and in practice to the bees and beekeeping, the reader will happily proceed further in this marvelous undertaking.

Bees Live in Colonies



Unlike many other insects, honeybees do not live as solitary individuals but in large colonies, in communities. Consequently, honeybees are called social insects.

The life of a bee colony is diversified and intricate.

The worker bees, what are they like? The overwhelming majority of individuals in a bee colony are females. During the course of evolution, they completely lost their ability to mate, rendering them incapable of continuing the species. They cannot reproduce because neither their body size, nor their strongly degenerated sexual organs will permit it. "Organs in rudimentary condition plainly show that an early progenitor had the organ in a fully developed condition; and this in some cases implies an enormous amount of modification in the descendants." *

However, these bees preserved their maternal instinct, as can be observed in their care of progeny. At the same time, they acquired certain biological properties which subsequently became highly developed. These new properties are of extremely great importance for the life of bee colonies: they began to build their nests and forage their food together, feed their large-size brood (larvae) together, provide the heat for the nest and to keep it at the level they desired, protect the nest from their enemies and pests. In brief, they began to accomplish all the jobs necessary for the life and activity of their community. They came to be called worker bees. Depending on the season, a colony may have from 10 to 80 thousand worker bees, and sometimes even more.

During the course of evolution, the morphology of the bee has un-

* Ch. Darwin, *The Origin of Species*, London, John Murray, 1906, p. 662.

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dergone considerable changes, especially with respect to her most important working organs. Her proboscis, which is a device to collect the nectar, has become much longer. With its help, the bee can now take the nectar from flowers of almost all plant species. The organs in charge of collecting and transporting the pollen have also improved; the honey stomach (honey sac), which is the reservoir for nectar and water, has a larger capacity; the wax and maxillary glands of the bee have, undoubtedly, begun working more intensively.

The necessity to store huge food reserves for the colony and the offspring has resulted in the bee's enormous capacity for rapid orientation, for finding nectar and pollen, and for informing the colony about such discoveries.

The orderly structure of her body, the rapidness and sharpness of her reaction, the extraordinary energy and working capacity of the bee—all these qualities make this insect absolutely unique and the most useful of all social insects living on Earth.

The behaviour of worker bees depends on their age, the conditions within their nest, and the surrounding environment. Young bees do not perform any jobs during the first two days of their life. They are yet too weak and need to be taken care of. At the age of three to four days, they begin cleaning honey-cells in their nest; as their maxillary glands develop adequately, they start feeding the larvae, and as the wax glands mature for functioning (after five days), and particularly when they can work at full capacity (at the age of 12 days), the bees begin constructing the honeycombs. When they are 18 to 20 days old, the bees usually begin to collect honey. Before that, they guard the nest. In the last days of their life the bees carry water and do not fly far from their home.

It is interesting to note that in accomplishing their different tasks and duties, the bees demonstrate some kind of narrow specialization: the youngest of all are dedicated to feeding the older larvae only, whereas the bees whose maxillary glands fully excrete jelly are in charge of feeding the young larvae. The foraging bees do not pay their visits to all plants they encounter in their flight, they favour the flowers of a certain single species. If a bee collects honey from the flowers of white clover, she flies by all other melliferous plants simultaneously blossoming but yielding less nectar. Honeybees are known to be persistent in their devotion to the same flowers, which is very important for the plant kingdom. It is true, nevertheless, that a foraging bee can work simultaneously on several species of melliferous plants, but it happens only in places overpopulated with bees or poor in honey-bearing plants.

Over the course of evolution, bees developed another quality of

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A dancing bee is surrounded by bees.



A tree hollow where a bee colony lives.

great value: irrespective of their age, they are capable of switching from one job to another if it proves to be more vital for the colony because of sudden external environmental changes.

During a heavy honey flow, when the colony tries to store as much food as possible, the nurse bees switch to receiving and processing the nectar, while younger bees take over the functions of the former. When the gathering forces are small, the honey harvesting may be carried out by bees which are but newly acquainted with the locality, and which have not yet taken part in the construction of honeycombs.

If some flying bees when en route happen to be caught by a heavy rain, thus preventing them from returning home, or if many bees are killed by poisonous chemicals used to treat the field crops, the system of functioning according to age is disrupted: the nectar flow will again be collected by younger bees.

Despite their profound biological capability to do the job typical for their age, the colony of bees demonstrates a great mobility in finding the necessary reserves to be allocated to the tasks which, due to the circumstances, attain primary importance.

Naturalists, scientists, and beekeepers have always been fascinated by the most logical pat-

Bees Live in Colonies

tern of honeybees' life, remarkable order in their hive, where everything seems to be wonderfully thought out and perfected, down to the finest trifles. There are never any conflicts between the members of the bee community, as if all of them were guided and governed by some laws accepted once and for all, though the meaning of these laws is clear only to the bees alone.

So, a very intriguing question may be asked: how is this high level of organization maintained in a colony of bees which is, indeed, a gigantic accumulation of many thousands of insects? It is literally within fractions of minutes that a bee colony responds to any environmental circumstances. Who sends the bees the alarm signal?

To date, the intricate language of honeybees has been decoded to some extent. Theirs is a language of sounds, gestures, and scents.

If you approach a hive closer, you will be able to hear the noise made by the bee colony; the noise is rather smooth, low, dull, and seems to be composed of one voice. This is the voice of the bees' everyday ordinary labour. If you knock slightly on the hive, you will immediately hear an alert or strict response of the bees ready to defend their hive. Honeybees are extremely sensitive. They are capable of emitting and receiving



At the bee entrance.



A nest in a tree hollow.

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ultrasounds, oscillations as small as a hundred thousandth of a millimeter; and their reaction to such alarms is immediate.

If the noise from the hive is unharmonious, revealing some grieving and peeping voices in this or that end of the hive, it means that the colony has lost its queen, and now the lonely bees seem to be complaining about their misery, requesting urgent help.

Of exceptional significance in the life of the honeybee community is the so-called chemical language, i. e. consisting of various odours and scents. The very nest of honeybees is saturated with aromatic substances: the nectar and pollen of the most diversified plants; propolis of beech, poplar, aspen; the wax and hormonal secretions of the queen, ordinary bees and their brood – all this provides for the unique, sweet-smelling aroma of the hive. This fragrance is a kind of password characteristic (specific) for each colony; it serves as a pass for the bees to enter their home upon returning from their flight.

The secretions from the queen's skin glands are dispersed by the bees throughout the nest, promoting the integration of their colony and stimulating their activity, making their life so wonderfully ordered. But if the queen gets lost, the hive immediately receives a signal of alarm and distress, and the colony gets greatly excited. Bees are capable of detecting the age of larvae in the darkness of the hive by their pheromones and of supplying the larvae with the food they particularly need. Queen larvae are thought to produce a pheromone different from those of the worker bees, and the nurse bees give them a special, royal jelly.

The specific smells of queens' sexual pheromones attract the drones during their nuptial flights.

Thus, smells govern the behaviour of bees; they provide for the life and activity of a bee colony as an integrated biological organism. The chemical language, with all of its varied forms, is the oldest and most universal one governing the interrelations of colony members.

There is another very important means of communication between the bees in a colony, namely, they move in a special way when they are on a honeycomb. These movements are known as bees' dances. It is true that, like in any real dance, these movements have a certain rhythm, definite figures, rather frequent turnings and runnings. The old Russian beekeepers, who were famous for their keen observations, called this unusual behaviour of bees their folk dances. These old people believed that bees burst into dancing when they are happy and gay, enjoying a good honey yield and flow. When some bees are dancing, others who are nearby reveal their great interest in this dance, too, begin to follow the former and to repeat their movements.

It turns out that by dancing, the bees convey certain information.

Bees Live in Colonies

Using their language of gestures, the scout bees can show not only the place where the source of food is situated, but also the distance to that place, as well as the amount of the honey yield. This all-embracing information seems to be simply fantastic!

A strong colony has more scout bees than a weak one. In the former, there is a better information service, helping the colony members to detect the honey flow faster, and mobilize for its exploitation and utmost use.

Which bees are better. Honeybees have settled almost all over our planet. They live both in regions with cold climates and long and severe winters, and in the tropics, where winter never occurs and the summer temperatures are usually very high. Bees' adaptability to different climates and environments has proved to be genuinely amazing. As a result of specific climatic conditions and peculiarities of nectariferous flora, there historically developed various breeds of bees, differing in their appearance, character, and even morphology. Particularly great differences are found between northern and southern bees.

In this country, there are several very valuable bee breeds. Among these, the most widespread are *Middle-Russian forest bees* (*Apis mellifera mellifera* L.). They live in the northwestern and central areas of this country, in the Urals, Siberia, and Far East, where they are successfully bred and kept.

The bees are dark and slightly brownish and are thickly covered with fine hair which is very important for their survival in the local cold climate. The little hairs covering their bodies are very long, up to 0.5 mm. Their body size is conspicuously larger than that of the southern bees, thus the volume of their honey stomach and the area of their wax-secreting glands prove to be considerably greater. These two features are of great importance for biology and agriculture. Dark forest bees are excellent builders. They can quickly renovate their nests and construct many honeycombs.

Queens of Middle-Russian bees are known for their high egg production, they can lay as many as 3 thousand eggs per day, and even more. Their colonies grow up and vast very fast. By the time of the main honey collection, such colonies accumulate many bees and large brood. Their swarming is rather moderate if they are kept in spacious vertical hives, provided the honey flow is good. These bees can be treated with anti-swarming preparations.

The working capacity and industriousness of forest bees is unique. They are universal in using the honey flows and can get quickly mobilized on taking them. These bees can work splendidly literally on all

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arboreal, shrub and bush, as well as herbaceous plants which secrete pollen and nectar. They gather especially large quantities of honey from strong nectar plants. Record collections of honey from the linden and willowherb were gathered by Middle-Russian bees. They are also justly regarded as the best pollinators of buckwheat.

The Middle-Russian forest bees can well withstand the climate in regions with severe and long winter months, and this is extremely important for practical beekeeping. These bees are very economical. When the honey flows are scarce, they carefully economize their food and thoroughly protect their stored reserves. Even when the honey harvest is insufficient, these bees can give us honey.

To protect the pure-bred Middle-Russian forest bees, in most regions of their natural habitat it is forbidden to import bees of other breeds.

In the mountains, valleys and forests of the Caucasus, there live wild *mountain Caucasian bees* (*Apis mellifera Caucasian* Gorb.) which are well known throughout the world. They are mainly bred in the southern areas of this country. They are light-gray and silvery and are somewhat smaller than the Middle-Russian bees. Their character is peaceful and quiet. Even when taken off of their honeycomb, they continue feeding their larvae, working with the pollen, and dancing, while the queen goes on laying her eggs. Their proboscis is the longest of all bees. It may reach 7.2 mm. Thanks to it, these bees can extract nectar from long-tubular flowers, including those of the red clover. In areas where this valuable fodder crop is cultivated, beekeepers usually do their best to breed the gray Caucasian bees.

The Caucasian bees do not swarm much, they do not build many queen cells, their queens lay fewer eggs, as compared with the Middle-Russian bees, and by the time the main honey plants bloom, the masses of the Caucasian bees' families or colonies are not large. When harvesting the honey flows, even those of small volume, the area for the queens' egg-laying is usually restricted by the foraging bees, thus their colonies cannot properly gain any large mass before winter comes. This may be why Caucasian bees suffer heavily during long winters. In addition, the activity of catalase, the enzyme of their rectal gland which determines the success of their wintering, is considerably lower than that of the winter-hardy bees of the Middle-Russian breed.

The gray mountain Caucasian bees are better adapted to collect honey flows from meadows of mixed herbs. When working on such mighty nectar plants as the linden, these bees are rather lazy, they prefer herbacious flora. They almost never visit the plants of buckwheat which seem to be absolutely foreign to them. In the areas of their natural habitat this crop has never been cultivated at all.

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Italian golden bees (*Apis mellifera ligustica* Spin.) live chiefly in southern Europe, the USA, the countries of Latin America, Canada, Australia, and India. In this country, the Italian bees are bred in the southern Ukraine and in Moldavia. Italian bees are very gentle and quiet in character, and they withstand long winters well. The Italian queen bees are the most productive of all, and the communities of these bees are much larger than those of other breeds. Italian bees can take all kinds of honey flows. However, if a honey flow is poor and long and the egg-laying of the queens is not restricted by man, Italian bees fail to store (accumulate) sufficient quantities of honey, because the nectar they harvest is used mainly to raise their brood.

The *Carniolan bees* (*Apis mellifera Carnica* Pollmann) in their appearance and behaviour resemble the gray mountain Caucasian bees, but the former have on their abdomen some broad, semi-ring shaped belts. The Carniolan bees originated in the Alps. They can be found in the Balkan Mountains and along the Carpathian ranges. These bees are most widespread in Yugoslavia and Austria. They are also bred in Czechoslovakia, Hungary, Rumania, and some other countries of Europe. Lately, Carniolan bees have been introduced to this country as well, and today they are bred in the Byelorussian republic, Baltic republics, and Central Asia.

Bees of this breed are very valuable for biology and agriculture: they tolerate moderately cold winters rather well; in spring, their colonies rapidly grow in size, accumulating good reserves for the time of the main honey yield.

Their swarming capacity is high but they can be easily treated with anti-swarming preparations. Consequently, Carniolan bees can prolong their growth period and well prepare themselves for the honey collection at hand. Like the Middle-Russian bees, these work well on buckwheat plants.

As we see, bees of different species vary in their capacity to accumulate their live mass and to use the main honey yield. They differ in terms of their gentleness and peacefulness, their resistance to diseases and winter conditions.

It goes without saying that every beekeeper would like to have the best bees possible so that they will provide him with as much top quality honey as one can imagine. Unfortunately, so far no bee-breeder has managed to develop such a cultured stock of bees which can meet all his requirements, though many selectionists did try to do so. Therefore, they believe that it is most profitable and beneficial to raise local bees which have adapted to the local climate and vegetation over the course of many centuries. Of course, local beekeepers should logically take into account the latest achievements in the science and practice of apiculture.

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The queen is the progenitor of the colony. Among the great number of the colony's worker bees, i. e. females, it is only the queen that has preserved her sexual instinct and is capable of reproducing. This function has become the most vital one in the queen's life, but her other instincts governing all other jobs and duties within the nest and on flowers have completely disappeared.

The morphological transformations and physiological changes which the bee and the queen-bee have undergone during the course of evolution were highly expedient. They marked a biological process which resulted in the further prosperity of the species.

The queen is constantly in her nest. She leaves the nest only when she is a virgin and waging her sexual hunt. The first time, the queen flies out to get acquainted with her home and become oriented with the locality. This orientation flight usually takes place in the warm and quiet hours of early morning, in the very midst of the bees' intensive flight while the drones keep to the nest. It is for the second, third and sometimes even fourth time that the queen leaves the nest for her nuptial game. As a rule, this is the time for young bees to start their exercise, and along with them the blue sky attracts the drones.

Without any delay over the apiary, the queen flies further on, sometimes as far from the hive as 3 or 4 km, occasionally even 6 to 7 km. Naturally, being so far from her own nest, the queen chances to meet drones from other colonies.

The queen mates with several drones, and if during her first nuptial flights she failed to receive a sufficient quantity of semen, she may leave the nest repeatedly. Owing to this multiple coupling of the queen, moreover with drones of colonies the queen herself does not belong to, nature has excluded any possibilities for the species to degenerate.

The queen also flies from the nest together with some young colony during swarming. The queen is larger than the worker bee, being almost three times heavier in weight. The queen's abdomen is long, fat, egg-shaped, her wings covering only half of her body. Depending on the breed, the colour of the queen differs from that of the worker bee; it may be lighter and softer, or, on the contrary, darker, more brown in shade. The Middle-Russian queens are obviously lighter in colour, the gray mountain ones are much darker, they are almost hazel, even coal-tar pitch; the Carniolan bees are dark-cherry, and the Italian ones are of a warm golden shade.

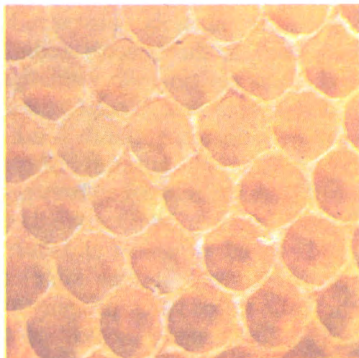
The queen which has just been born is not yet a colony's mother. Such a queen is yet a virgin. She will acquire her ability to lay eggs only after a few days, upon reaching her sexual maturity and after her mating with drone bees. Then she is considered to be fertile.

An immature queen is very adroit, she can all of a sudden make her

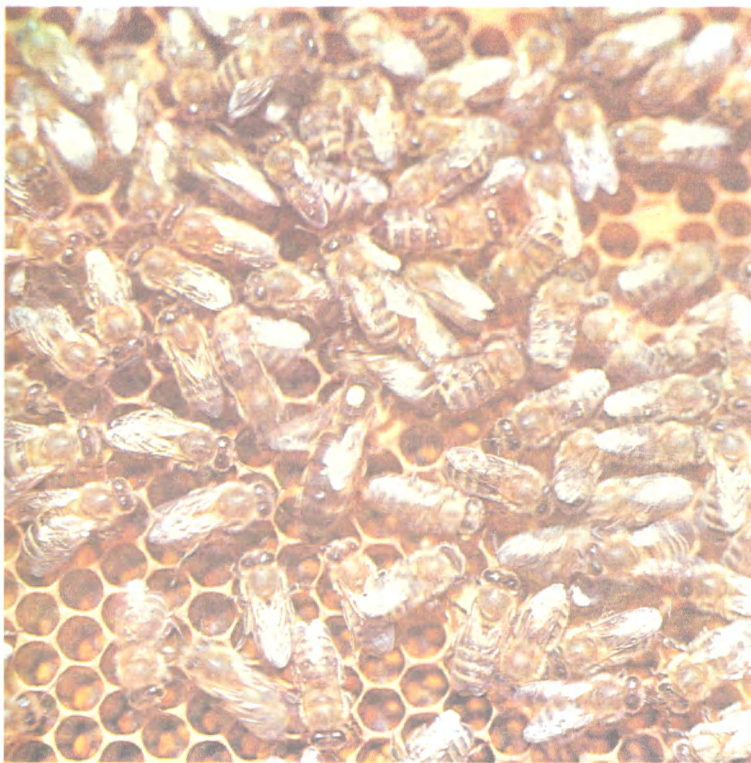
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A queen of the Italian breed.



Uncapped (open) brood.



Worker bees. There are tens of thousands of them in the nest and the queen is in their midst.

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appearance in most unexpected areas of the nest. After her mating with drones, the queen's sexual organs begin to develop eggs, her abdomen considerably enlarges, and the queen gains weight.

The movements of the fertile queen are slow and majestic. The fertile queen always keeps to food-free honeycombs into which she can lay her eggs. The latter are of two types: those already fertilized give birth to females (worker bees and queens); unfertilized ones develop into males (drones). Despite the fact that the queen has highly developed sexual organs and is capable of laying tremendously huge numbers of eggs, she has completely lost all purely maternal instincts: she cannot feed her progeny or take care of it.

The queen is the most important individual in a colony. It is the queen on whom the entire population of the hive depends, its numbers and power, the very rhythm of its life and its working energy. The queen seems to govern the entire community of bees. That is why the queen used to be called the empress and even the goddess of a race.

Nevertheless, in many ways the life and activity of the queen is determined by the bees in the colony. The queen will not be able to lay a single egg if the bees in the colony do not prepare properly and on time the honey-cells it needs. Due to the queen's inborn antagonism toward other queens, she never lays her eggs into empty cups, but the bees may compel her to do so; during swarming the queen leaves the nest against her own will only because the swarming bees compel her to.

When the queen is in good health, the colony thrives. But the moment the queen gets ill, the bees in the colony all become panic-stricken and fear for their very existence, and they hurriedly try to raise a new, young queen for their colony. When the queen dies, it is a calamity for her family, the functioning of the latter is completely disrupted. And if due to certain circumstances a colony fails to raise a new queen, then the colony is doomed to perish.

The queen enjoys the special care of her bees. Some of them prepare the honeycombs she will need, they clean and polish the honey-cells for the queen to lay her eggs in; others are always close to their queen, giving her food and tender care. The bees in the latter group are the queen's retinue (suite). The suite is not constant, it is composed of new bees on the honeycombs to which the queen passes to lay her eggs. "It is quite possible that the permanent care rendered by bees to their queen," writes Professor G. A. Kozhevnikov, "has killed in her any natural desire to search for food."

If a bee colony happens to be on the edge of starvation, the first to die will be the worker bees. The high rate at which they perish will not

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coincide with the complete depletion of their food, but it will begin somewhat earlier. They die so that the last crumbs of food still remaining in the colony might be used by their queen. They are driven by their instinct, so that their race will survive in their queen who will begin a new colony. The queen dies after all the others are dead, when there is absolutely no food left in the hive.

Female bees (the fertile queen and worker bees) are the foundation of a bee colony. With these elements in the colony, it is biologically complete: it can make its own nest, procure its food reserves, and continue its race by reproduction.

Drones are seasonal residents. Bees raise drones at the end of spring when their colonies become sufficiently strong and begin preparations for swarming. Drones are male bees and bee species cannot multiply without them. Bees try to breed as many drones as they can, they never hesitate to give each young drone huge amounts of food which would be sufficient to satisfy five or six worker bees. Adult drones consume even larger quantities of beebread and honey, and they are never refused anything they need.

The matings between the queens and drones usually take place in the open air, some 30 m above the ground and rather far away from the apiary. Drones can fly to mating places as far away as 7 km. To reach such distant places, they must have an extremely sharp sense of smell to be able to trace the flight of the queen; their eyes must be vigilant, their wings must be very strong and their body must have enormous physical power – otherwise the drones will never manage to see the queen and catch up with her. And nature has granted the drones all these qualities. The bee's intricate eyes consist of 4 to 5 thousand facets (tiny eyes); the eyes of a drone have 8 thousand such facets, owing to which the drone can embrace a vast field of sight and get oriented in space very easily and quickly. The drone's antennae are much longer, too, and the antennae are the most essential olfactory organs. Each antenna of a female bee and queen has 11 segments, while that of a drone has 12. The drone has a considerably greater number of sensitive olfactory pits which act as locators. Thanks to all this, the drone can sense the queen almost at a distance of 50 m.

Drones do not perform any jobs in the colony, they are simply not fit for any useful work, they have no working organs whatsoever. Even their proboscis is shorter. If all of a sudden the nest were to run short of honey, even though the flowers surrounding it were heavily yielding nectar, the drones would die from starvation because they would never be able to get the nectar or to collect the pollen by themselves. They can only eat the food stored for them by the other bees.

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Drones never take part in protecting or defending the hive. They are deprived of any sting. They cannot defend even themselves. And they have only one function—to fertilize young queens. As beekeepers usually say, every day of the week is Sunday for drones. For the sake of reproduction, nature has literally released the drones from all family duties and obligations. But for this generosity of nature, they pay a very high price—after their mating union with the queen, the drones immediately perish.

The number of males in a bee colony varies: there may be several hundreds of them in some colonies, and over a thousand in others. The maximum numbers of drones are observed in colonies of higher swarming capacity, or with poor nests, as well as in those whose queens have exhausted all the sperm reserves or have become old.

Drones remain in the colony till the end of the reproduction period. This time often coincides with the termination of honey collection, when nature's abundant supplies of food come to an end. When there is no more food in the nest, the bees drive the drones out of it. Well, there is a saying: "The drones in summer are in great want but in winter they are all thrown out into the cold." So the life span of drones is limited in time, being determined not by them wearing out physically but by the colony's physiological need for them. They do not die a natural death, as is the case with female bees, but they die from starvation (the bees drive them off the honeycombs) and from cold (the bees drag the weakened drones out of the hive).

But in the colonies whose queens have not yet managed to mate in time, the attitude towards the drones is different. There, the drones remain in the hive throughout winter and spring. Honeybees are capable of estimating not only the inferiority of their queen but her need in drones as well, since they are necessary to fertilize the queen.

The fact that there exist different individuals in the colony and that their numerical ratio varies is biologically justified. The huge numbers of bees living in one hive permit the colony to collect honey in summer within a very short time, and in winter they can better withstand the low temperatures of the season, as well as defend their home against any enemies. As to reproduction, this task is well accomplished by just one queen. The large quantity of drones guarantees that the act of mating will be successful. Biologists have noticed that drones do not scatter evenly in the air but concentrate in certain definite places, perhaps in areas where their meeting with queens is most probable. It seems likely that when drones concentrate in groups they can be faster detected by the queens who are trying to find them.

No bee can exist outside her colony. A bee can remain outside the colony only for the short period of time necessary for collecting the

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food or for recognizing the locality, and in the case of drones and queens—to accomplish their acts of mating.

A nest of hundreds of thousands of wax cells. Honeybees, like many other social insects, live in nests. In the nest they live constantly, raise their progeny, pile up and store their food reserves, find shelter against the cold, bad weather and all enemies. All vitally important processes of the colony's life take place in the nest.

The species of honeybees originated and was perfected in nature, and primarily in natural forests where it was easier for the bees to build nests and collect food. It is always much more quiet and warmer in the forest than in any open place; the vegetation there is richer and yields more juice, the plants in the forest provide nectar more reliably. In the distant past, bees used to construct their nests right on the tree branches. It should be mentioned that certain honeybees of our time still do this. When the climate began changing, and especially as it got colder and colder, the bees who lived in the woods were compelled to search for homes and shelter inside hollows of trees. The hollows resulted from the rotten piths of trees and over the course of time they naturally acquired the position in which those trees had grown before, i. e. they became vertical. The bees settling in such tree hollows made their nests following the vertical shape of the hollow, thus the nests were always narrow and high.

Procuring their food reserves for themselves and their offspring, the bees piled them up somewhere far from the entrance to their home, in the highest part of the nest, where they could better hide them from enemies.

The part of the nest attached to the flight entrance, where the fresh air was coming in directly, was used by the colony for raising the progeny which needed large quantities of oxygen for its normal growth. The same cells and occasionally honeycombs were the premises for the entire colony as if they were its winter cluster. If the bees moved within the nest, it could, naturally, be only upward, towards the stored food. The movement along the passages was also upward determined by the vertical position of the honeycombs.

Beneath the brood, there always remained some vacant, unoccupied cells. This lowermost free part of the nest, which the bees seem to keep vacant as a reserve, played a very important role in the colony's life, providing conditions for a static microclimate within the nest. In hot summer, some bees descend here in search of cooler rest, swarming bees also accumulate in this part of the nest. During honey flow, the bees use the vacant lower cells for storing their nectar harvest, and it is in these cells where they begin processing it. In winter, the unoc-

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cupied section of the nest mitigates the effects of sharp temperature changes and aids the removal of water and carbonic acid secreted by the bees' cluster.

This vertical shape of their nest proved to be the most convenient, having satisfied all the requirements of their life. During the course of evolution, the ability of this species to construct such vertical nests became an inherited characteristic. It is interesting to note that the nests of bees living in the mountains are also strictly vertical, though they are constructed in rock crevices and could be of any shape, even low and wide.

Bees make their nests of wax – the organic substance they secrete. Wild bees' nests have several, most often six or seven vertical, elongated strata which are oval towards the bottom. These are wax combs, separated from one another by a strictly defined distance (12.5 mm). At the top and sides, the combs are firmly attached to the wood. When two neighbouring combs are built, the building continues until the bees, working on the opposite combs, begin touching one another's backs. At the sides of these main combs, the bees, following the configuration of the hollow, construct several small combs which make up labyrinths. These bee-spaces allow the bees to move freely from comb to comb during any season of the year.

The honeybees build their nest from top to bottom. Their nests differ in size. A freshly made nest may be up to half a meter high. Later, as the stocks of honey pile up and the colony grows in numbers, the bees expand their nest, frequently up to 2 m in height. In this way, the size of the nest, in the first place, depends on the size of the bees' home, i. e. the tree hollow they live in. As a rule, when choosing among two tree hollows, the bees would give their preference to the larger one.

A bee's comb is composed of many thousands of segments (cells) fastened together by their common walls and bottoms. These cells are geometrically regular hexahedral prisms of a certain size. The bottom of each cell is made by three little rhombs sealed together. Three new cells adjust them on the opposite side.

This pattern of comb construction permits the bees to use their building material with great economy, as well as to conserve much of their working energy. In the whole of the animal kingdom, no other construction is known which equals bee honeycombs in perfection and mastery. As Charles Darwin wrote: "Beyond this stage of perfection in architecture, natural selection could not lead; for the comb of the hive-bee, as far as we can see, is absolutely perfect in economising labour and wax". *

* Ch. Darwin, *The Origin of Species*, London, 1901, p. 212.

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The cells in the honeycomb have various purposes: some are used to raise the colony's worker bees, others to cultivate its drones. The drone cells are used for storing honey; beebread is stored only in the cells of worker bees (cells for the drones are more spacious and the bees find it more difficult to press the pollen pieces there). To breed the queens, the bees build up special cells, queen cells, which they attach to the sides of the comb. These places are kept free from the brood and therefore large queen cells can be made there. It is possible that the bees find it more convenient to protect the queen cells from the queen, who always tries very aggressively to get to these cells.

The bees place the honey they make in the very top of the nest, at the easiest point to reach. When kept in such a high place, the honey is always warm and it is much easier for the bees to get it in the cold winter season or in early spring. Wild bees accumulate their honey during many years, and that is why one can always find large quantities of it in their nests. There are tree hollows containing as much as 15 to 20 poods of honey.* During winter, the colony can consume only a small portion of this quantity (8 to 10 kg). The amount of honey required in spring is several times larger because this is the season when the brood raised is the greatest in numbers. But even at this time, the stores of food are not greatly depleted: the bees replenish their reserves with fresh honey and pollen. *With the constant abundance of food in the nest (the activity of bees is always stable) the colony's life proceeds normally. It can grow well even in bad weather and when no honey yield is available.*

A bee family may occupy the nest completely by itself or only partially, depending on its own state and on the season. In early spring, the colony lives at the top of the nest, right beneath its food reserves. In this warmest part of their nest, which is free of honey, the bees begin raising their brood.

As the colony grows, it moves downwards, occupying more and more of the honeycomb areas. This process lasts as long as the colony keeps expanding, until their home becomes too small for them.

Depending on the season, the temperature in the nest may vary. When the offspring is reared, it may be as high as 35°C; when there is no brood and during winter dormancy the temperature in the nest may drop considerably.

The heat energy is produced by the bees themselves. But they also have another wonderful ability—they can regulate the heat and strictly maintain it at a constant level. Their thermoregulation is greatly aided by the very material the honeycomb are made of (wax is

* A pood is equal to 16 kg.

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a poor conductor of heat). The great amount of air which fills the empty cells of the honeycomb and the space beneath it also promote the bees' thermoregulation, as do the cocoons remaining in the honeycombs after the brood leaves them. The very honey, too, plays an important role in sustaining the thermoregulation of the bees because of its very high heat capacity. Having consumed the heat of the nest, like a water reservoir warmed by the sun rays, it can retain this heat for quite a long time, thus helping the bees to stabilize the nest temperature.

The nest ages with time: the freshly-built honeycombs are snow-white, then they become darker and take on a creamy shade: it looks as if the bees trample it down (stain it with their pollen) and polish it with their glue (propolis).

However, these honeycombs do not age as quickly as those in which the colony raises its new generations. Upon leaving the cell where she grew and developed, a young bee leaves there her cocoon (her jacket) weaved by the larva when turning into the cocoon; at the bottom of the cell, beneath the cocoon, she leaves her excrements. The greater the number of bees raised in the cell, the sharper the colour change. After two or three generations reared in the cell, the honeycomb becomes light-brown; when the next three-four generations grow up and abandon the honeycomb it turns brown, after 12-15 generations it looks dark-brown or even black.

The ageing of the honeycomb is accompanied not only by its natural change in colour, but also by the decreasing volume of its cells.

For example, a freshly built honeycomb of the Middle-Russian forest bees has a cell diameter of 5.6 mm which decreases to 5.2 mm after 15 generations grow up in this comb. If the colony goes on raising its brood in such honeycombs, the young bees will be smaller in size and weight, and, naturally, less capable of working.

The colony instinctively feels the ageing of its nest. The bees try to delay the process by gnawing the cocoons out and by deepening the cells through additionally built walls. But there is not much they can do: they cannot free the cells from the cocoons.

The honeycombs age sooner when situated in the middle of the nest where the colony raises more generations during one season than in those at the edge of the nest. The queen begins laying eggs in the middle of the nest as early as in winter, finishing her egg-laying in late autumn.

When living in apiaries, honeybees inhabit hives. The most common are vertical hives, and among them multiple-storey (British) ones and 12-frame hives with movable brood chambers. Horizontal hives –

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long ones—with 16-24 frames are also quite popular. It is generally accepted that the best shape of the hive is multiple-storey which is the closest in form to the bees' natural home; it best corresponds to their biology, as well as to the requirements of practical beekeeping.

The bees build their nests in the hives not arbitrarily as in a tree hollow, but on a wired foundation which is specially made by a machine and provided to the bees in frames. The size of honeycombs is determined by that of these frames. The foundation speeds up the construction of nests, helping the bees to halve their expenditures of the formative material they use. The honeycombs built on such foundation are stronger.

Frame hives differ from the bees' natural homes in that they can be dismembered into separate parts, thereby dismounting the very nest, in order to determine the quality of the colony and its state. Thanks to this advantages of the frame hive, it is possible to study the biology of the bees and to actively interfere in their life: to decrease or increase the volume of the nest; to replace the old and worn-out honeycombs by new and fresh ones; to feed the bees when their food is bad or scarce as well as to extract the excess honey; to help the colony gain as much strength as possible and to control hardships and diseases; to promote the multiplication of the colonies or to hinder it, if necessary, when it does not seem profitable. In other words, thanks to the frame hive we could penetrate into the mysteries of the bee's life, to understand the regularities of its natural development, and master the ways of commanding the bee as we like.

The colony keeps on getting younger. A bee colony may exist as long as it is not destroyed by some calamity (for example, by a forest fire, a flood, a hurricane, an invasion of a bear). The colony may die from diseases, starvation or wrong care and treatment. But all this does not mean that the bee colony never changes its status and state, and is subject only to the process of ageing. It is the queen alone that can survive for as long as five or six years because of her tremendous reserve of vital energy. The rest of the colony steadily changes, renewing its composition even within one year.

The bee's life span is very short. It is determined by their time of birth, the conditions of their life, the expenditures of their energy. The bees raised in spring and summer can only live for 40-60 days. They perform the hardest jobs of the season: they raise the offspring, build the honeycombs, gather the forage. Their burden being too heavy, they soon reach their vital limits and age too early, and soon die. Many bees perish even sooner because they fail to withstand various diseases, or due to toxication, or as prey of their enemies. It may

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happen occasionally that all old (field) bees die. And, despite all this, the colony still survives. Thanks to the exceptionally high fertility of the queen, the nest keeps accumulating new reserves of young bees and brood wherefrom the colony can gradually restore its power, replenish its stock and go on living and growing.

The bees born in autumn, which do not have to do any hard jobs, live as long as nine months, i. e. several times longer. But before they die in spring, they manage to raise a number of new generations, starting their work as early as during winter dormancy. It is believed that if the bees did not work so hard and did not spend their energy fund provided by their genes, they could live for one year at least.

The queen, even though she can live several years, never survives until a natural death. Her extremely exhausting egg-laying wears the queen out long before that. The bees feel when their queen's last hour has come. Long before their queen becomes too old, they rear a young queen to replace her. The colony immediately starts raising a new queen if the old one suddenly perishes while the young brood is still in the nest.

The replacement of the old queen by a young one is foreseen by nature itself in the very act of the species' reproduction, i. e. by swarming.

So, the colony of honeybees constantly experiences rejuvenation.

The life of the bee colony is harmonious. The life of the bee colony is inseparable from that of the plant kingdom. As long as the latter is in its winter dormancy, the life activities in the bee colony also diminish, the bees become passive, they feed on stored food reserves.

When nature wakes up, particularly when the bees can obtain fresh food, the bee colony undergoes a transformation. It was not very long ago that the bees would not leave their nest trying to conserve as much of their reserve as they could. But now it seems as though all fear for their existence has left them. Their nutrition being richer, the bees become stronger and work with more energy, they renew their cells, construct new honeycombs. The queen lays more and more eggs. By the time the main nectar plants burst into blossom – these plants supplying the bees with the nectar they so badly need – the bee colony reaches its maximum size. Hence, the colony is able to procure the amounts of food necessary for the further existence. In autumn, when nature begins to slow down, the bees by and by curtail all of their activities.

Each of the colony members, of which there are many, is engaged in a labour which is vital for the whole colony. It should be noted that it was in this direction that the natural selection in social insects was

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proceeding. Some bees spend every day, from morning till night, outside their home in search of food; others feed the offspring, build the combs, produce the heat, guard the nest, and so on. Each job is performed by a group of bees which are of the same age. Particularly large are the groups engaged in getting the nectar.

The colony is working day and night, every minute of the clock, every season of the year, even in winter when the bees are almost completely dormant.

Every bee seems to be doing her labour quite independently of the others, but it is these very separate activities of the bees that contribute to the harmony of their colony as a whole and integrated body. The colony immediately responds to any disruption in the smoothness of their life, trying to restore it at any cost. For example, if suddenly the old bees die in large quantities due to a strong shower or hail, the colony will immediately replace them from reserves which, under normal conditions, would be engaged in other jobs more suitable for their age. If a colony happens to lose its nest (a swarm living in a tree hollow), almost all of its members will at once start building a new one.

All working operations in a bee colony, unlike any other community of insects, are performed with the least possible expenditures of labour, time and material. The hexahedral shape of the cell, for example, does not only permit the bees to spend the least possible time and wax on its construction, but also to build honeycombs of exceptional strength and capacity.

Flying from their nest to the field of blossoming nectar-bearing flowers and back, the bees always choose the shortest possible route, and, if the locality is open, they follow the straightest line. When in the wood, they frequently fly by cuttings; in calm weather, they usually fly over the trees and between the tree crowns, if the forest is sparse. In windy weather they seek shelter in the forest's edge. In the mountains, they stick to valleys and avoid high summits.

The bees usually prefer to collect the pollen or nectar from plants of a certain species when the latter are in blossom. This ability helps them to save a lot of time and energy. "That insects should visit the flowers of the same species as long as they can, is of great importance to the plant, as it favours the cross-fertilization of distinct individuals of the same species; but no one will suppose that insects act in this manner for the good of the plant. The cause probably lies in insects being thus unable to work quicker; they have just learnt how to stand in the best position on the flower, and how far and in what direction to insert their proboscises. They act on the same principle as does an artificer who has to make half-a-dozen engines, and who saves time by making consecutively each wheel and part for all of

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them. Insects, or at least bees, seem to be greatly influenced by habit in all their manifold operations.”*

During their evolution, the bees have worked out a mechanism to prevent many diseases and, if the latter are unavoidable, to cure them to some extent. The chitinous coat of the bees has antibiotic properties, i. e. it can suppress the growth and multiplication of harmful microorganisms and even kill them. There are antibiotic substances in beebread, in the food for larvae, in honey, and even on the honeycombs. The bees cover the walls of their nest and honeycombs with propolis (a kind of organic resin) which inhibits the growth of pathogenic microflora. Larvae, weakened by diseases or dead, are carried out from the nest to reduce the spread of the disease. The colony uses all possible means to combat diseases, and is often victorious. The bees clean their stomachs outside their home, when flying. Thus they reduce the possibility of stomach diseases. They also leave their nest when preparing to die. But if death finds a bee inside the hive, the others will immediately take the dead bee out of their home and as far away as they can. The bees do not tolerate any rubbish in their nest; when cleaning it, they immediately remove the slightest speck of dust.

They kill all enemies who intrude into their hive, and the dead bodies are immediately expelled. If the burden is too heavy for them to carry (say, the foe was a mouse or a big butterfly), the corpse is im-mured with propolis which is famous for its anti-microbial properties. Encased in such a peculiar tomb, the corpses of their enemies do not rot and are no longer dangerous for the colony. The bees always try to keep their home and nest ideally clean. All this manifests the bees’ wonderful instinct for self-preservation.

So, a bee colony, though it is composed of many thousands of individual bees, is also, in reality, an integrated organism of intricate construction; its life activities follow the general laws of biology typical for all of living nature.

A bee colony, like all other living creatures, is born, develops, reproduces; it fights for its existence. The bee colony has complicated and many-faceted interrelations with its environment. All of its life activities, like those of any animal with a highly developed nervous system, are ruled by instincts – the in-born abilities to respond to different stimuli by concrete actions. The instincts of the bees, no matter how complicated they may be, can be manipulated by man to some extent, and employed for man’s benefit.

* Ch. Darwin, *The Effects of Cross and Self Fertilization in the Vegetable Kingdom*, London, John Murray, 1878, p. 422-423.

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Caution in treating the bees is the beekeeper's first commandment. By their nature, honeybees are peace-loving creatures. Any aggressiveness without reason is unnatural in the bees, likewise in any members of the animal kingdom. If the bees are not touched and disturbed, they will never attack anybody by themselves. They use their sting only for self-protection against some strong stimulus (threat).

To fear the bees is very typical of most people, even the most courageous and brave ones can be frightened if a bee suddenly happens to fly up to them. But if people understand the life of these wonderful insects better, they will easily realize that their fears are groundless. There are many cases whereby upon learning more about the bees, many people turn into ardent beekeepers.

To put it figuratively, man has been on friendly terms with bees for many thousands of years. Bees are protected by man, but nevertheless, they are constantly attacked by their numerous foes and enemies, and their fears have not diminished. All their troubles are due to their treasure—their honey, which is a most valuable product, unique in its rich content of nutrients and medicinal substances. Even man, who having uncovered certain great mysteries of nature, subjugated the energy of the atom for his own needs and designed inter-planetary aircrafts, even he cannot invent a food stuff as valuable as honey. The hoards of this priceless treasure are always attractive to the numerous enemies of the bees, including tiny insects which one hardly distinguishable by the naked human eye, and all kinds of larger animals like martens and bears.

Nature has endowed the bees with a powerful weapon to fight their enemies, that is their sting with its lethal poison. One stinging bite of a bee is sufficient to kill any insect or small animal, such as rodents; when stung by a hundred bees, even a big four-legged animal can perish. The might of this weapon was experienced by primitive man, too, when he first tried to penetrate into the nest of wild bees to take their honey. At that time he was unaware of ways of taming the bees.

Finally, after long communication and contacts with the bees, first with those living in tree hollows and then with bees in hives, man managed to find means and ways to tame the bees. He also elaborated special rules by which to treat them. These rules are indispensable to any beekeeper. They are to be strictly observed both by an experienced beekeeper and by a novice who is just beginning to learn the tricks of the trade.

The bees have an extremely sharp and delicate sense of smell. In nature, they constantly encounter thousands of various flower smells from simultaneously blossoming plants. Out of this tremendous variety of smells, the bees are capable of distinguishing the smells of

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those plants which provide them with their food. The bees detect the smell they need when flying hundreds of meters away from the flower they are seeking. Is this fact not surprising?

Each colony has a stable and specific smell of its own, which allows the bees to immediately detect those of their own colony from strangers, their own queen from a foreigner.

The bees respond to all smells. Some of them, coming from the kingdom of plants and flowers, make them happy and excited, mobilizing them to search for nectar or pollen (these responses were employed for training bees to collect the nectar from special plants). Other smells, foreign to bees, particularly the smell of sweat, alcohols, onion, garlic, eau-de-cologne and perfume, make them irritated and angry, even mad and furious. That is why the bees most frequently sting animals having unpleasant sharp odours, such as horses, goats, dogs. But even in such cases, they attack these animals only when they happen to be in the vicinity of the bees' home. This behaviour, most logically, should be understood as their reaction to some impending menace.

The bees react most vividly to the smell of their own poison. It is a signal of alarm of primary importance for any bee. As soon as a man or an animal is stung by one bee, scores and hundreds of furious bees immediately attack the same victim.

So, not to irritate the bees while working in a hive and to protect oneself from their stinging, the beekeeper must, in the first place, observe the rules of personal hygiene, wear clean clothes only, and never eat any food with strong smells before going to work with his bees.

Bees are irritated by wool, hair, dark clothes. Maybe this is all due to their memory of the harm inflicted by bears and martens whose wool is thick. Their century-long struggle against these animals might have instilled in bees such a reaction to wool. It is also possible that, fighting the thick hair of some animals, they fail to get out of the hair thickets and regard the latter as a threat to their life; hence, getting furious, they counterattack the intruder. In any case, bees always respond negatively to these stimuli. That is why men with beards should cover their face and head with a special net of tulle, and wear a working suit of light cotton cloth. The most convenient clothing for beekeepers is overalls.

The bees may get furious when one makes sharp movements, such as running over the apiary, waving the approaching bee off, sudden movements of the hand over the nest, towards the frame of the hive, to the smoker, or to the stung place on the body with the intention of whisking the bee off as soon as possible, so as to remove her sting, and so on. Such sharp movements excite the bees' alertness and alarm

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them as they begin fearing for the safety of their nest. Therefore, their response to such quick gestures is entirely defensive.

Caution in dealing with bees is a most important commandment. L. N. Tolstoy deeply loved bees and knew their character perfectly well. He used to say: "In treating things, one can have no love for them: we can cut wood, make bricks, forge iron without any love whatsoever; but we cannot deal with people without loving them, as much as we cannot treat bees without caution. Such is the nature of bees. If you begin treating them without caution, you will harm both them and yourself."

Bees quickly react to subjects hindering their flight, such as a tree or a shrub in the near vicinity of the entrance; or a man having approached the hive from its front wall.

The standards of behaviour for any beekeeper are as follows: walking over the bee garden, one should always be quiet, the movements of the beekeeper's hands when working in the hive should be smooth, one must control his emotions if stung and withstand the pain calmly.

The beekeeper must know another very important characteristic of bees, namely, their reaction to smoke. The smell of smoke immediately excites the entire colony very much. The bees, as if by an alarm signal, greedily attack the honey and swallow it up. This alarm signal is associated with smoke in the bees' response to the latter. Smoke is always followed by fire (forest fires) and fire has always been the most terrible threat for all forest dwellers, including bees.

To save themselves from death and flee from the fire, the bees instinctively store the most vital necessity for their subsistence, namely, honey, which is the only source for their survival in their first days outside their home. This response to smoke has been reinforced in the bees and turned into an inherited feature. Small doses of smoke, artificially introduced into the bees' nest, induces a defensive response in them even today. But now they would never leave their nest, since such smoke is not accompanied by a fire.

The behaviour of bees when their honey sacs are filled is simply amazing! They become much less irritable and almost never sting. This peculiar feature of the bees was noticed as far back as in the days of primitive man. When he wanted to penetrate into the bees' nest to take their honey but not to disturb the colony in any harmful way, primitive man used a piece of a dry wood punk which gave off a lot of smoke when smouldering. For the sake of convenience, such pieces of punk were placed inside the smoker later. The smoker enabled them to direct the smoke to any spot inside the nest and in the quantity desired at any given moment. Smoke is the strongest means of taming the bees. It makes the colony more obedient and quiet. Using smoke,

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one can penetrate the nest of a most angry colony and do there any job necessary. The smoker is the "right hand" assistant to the beekeeper.

Not all bees react the same to the same stimuli. Their responses depend upon the individual properties of the colony. Nevertheless, the Middle-Russian forest bees tend to become irritable and furious rather easily. Quite opposite in their behaviour are the bees of the mountain Caucasian breed, Italian bees and Carniolan bees (they are calm and peaceful).

Even the very same colony may behave differently under different circumstances. In the morning, when all bees are still in the hive and the daily work in the field has not yet started, or at the end of the day when all bees get together again after their work in the field, they respond to any interference in their life much more quickly and sharply than during the daytime when most of them are engaged in their busy flight. The bees get more infuriated when inspected in gloomy or windy weather, even during their honey flow. When they are not engaged in honey harvesting, the colony becomes angry and irritated, particularly after their honey harvest is suddenly interrupted. The bees feel nervous and angry because they fail to find either honey or nectar, nor any pollen, and they have to return home without anything. They are also angry because of the never ending attempts of robber bees to deprive them of their stored reserves. If one ventures to inspect the colony at this moment, the bees will become most furious.

During their honey flow, which is especially intensive when the bees are engaged in gathering and processing the nectar, they become quieter. Even the robber bees do not alarm them as much as before, because now the robber bees are also busy collecting honey, and they do not need to rob the hives of others any longer. Nature has now become generous and hospitable to anyone who is not lazy to take its gifts.

During honey flow, the nest can be inspected, if necessary, at any time of the day. But it is better not to disassemble the hive if it is not the honey harvest time. At the latest, this operation may be performed at the end of the day, when the bees will almost cease flying.

It is much easier to prevent the bees from getting furious than to calm them down once they have already started stinging.

As Professor G. A. Kozhevnikov writes, "Many beekeepers, especially beginners who lack experience, try to do their best in search of bees which do not sting. But one should not think that "quiet" bees are more advantageous than those inclined to stinging. This advantage (in terms of the honey harvest) has not yet been proven by anyone. And moreover, there is a certain disadvantage in dealing with

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quiet bees: it is much more difficult to learn how to work well with them than when dealing with angry ones.

The thing is, that when a bee is "angry", the beekeeper knows what she "did not like" in his behaviour and he does his best not to do anything to irritate the bees. "Angry" bees prove to be like strict teachers: in case the beekeeper mistreats them, they will punish him by stinging.... But if he works with them quite skillfully and carefully, he will not be stung. So, in teaching someone how to keep bees, it is of no benefit to have very quiet bees: one will never know whether he treats them properly or has committed a blunder." * And N. M. Vitvitsky, who knew well the splendid properties of the Middle-Russian forest bees, gave this piece of advice: "Love furious swarms: they can enrich not only you alone but your great-grandchildren as well."

Bees can rob. Any interference in the bee nest, even a most trifling one, can disturb the harmony of the colony's life, violate the work rhythm in the hive and field. Furthermore, the nurse bees stop nursing the brood for some time; the clusters of worker bees disintegrate (it is easier for the bees to maintain a high temperature in such clusters, which should be above that in the hive, so that they can intensively produce wax and soften its plates); the queen is left alone without her retinue, she goes deep into the hive and stops laying eggs for some time (particularly easily frightened are the Middle-Russian queens); the bees' flight to collect the honey sharply decreases, likewise the guard at the flight entrance.

This kind of colony's behaviour is quite natural. All vital processes of the bees' life inside the nest go on in almost complete darkness. Light penetrates the nest only through the flight entrance, and even this light is very weak and reflected. When the hive is opened, the entire nest is swept by a flood of direct and unreflected rays of light. The effect of the light, as well as the very intrusion into their nest, disturbs the normal life of the bees' colony. This state of disturbance may be short and superficial, i. e. it may involve only small groups of bees if the nest is opened only in part and for a short while. But it may last long, and deeply affect the entire colony. In the latter case, the fault is entirely that of the beekeeper who failed to perform his operations skillfully enough: it is certain that he probably opened the nest for a long time, that he tried to displace the frames inside the hive when it was, most probably, not at all necessary, but just for the sake of curiosity.

* G. A. Kozhevnikov, *Breeds of Bees and Ways for Their Improvement*. Moscow-Leningrad, 1929, p. 49 (in Russian).

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The bee colony, so greatly infuriated, may remain unnaturally angry for several days after such an intrusion.

An open hive emits a strong honey smell. Bees, with their extremely great capacity to discover food, can feel that smell at a large distance of tens of meters, and in windy weather at a distance of hundreds of meters. If at this time the natural honey yield is scarce or absent (more frequently, it is poor), bees, flying by this open hive, will immediately change their direction and rush to the aroma. Since the colony inside the hive they are now inspecting is disorganized, to penetrate into its nest is not difficult, and the invaders rush inside and get drunk on the honey. Having stolen the hosts' property, the robber bees carry their spoils to their own nest. But before that, they manage to mark the locality of the robbed hive and memorize it (a robber bee, overloaded with stolen honey, with difficulty flies up into the air and, to memorize the place, makes several spiral flights above it, each circle large in diameter). Meanwhile the robber bees leave a certain trace by which to orient themselves in that place, it is a specific kind of a smell diagramme by which other bees would be able to find this food source.

Not more than a couple of minutes later, the robber bee again appears at the same hive, but this time she comes not alone but with her friends. Together with this bee, and occasionally even before her, arrive scores of other bees which the first robber has already managed to inform about her discovery. And all these bees try to penetrate into the hive. Even it may be already closed by this time, the invaders' thirst to get inside and at the honey has not been quenched. The robbers persistently fly around the hive, trying to find any, even the tiniest hole to pass through, which is not guarded properly by the hosts. Failing to find any, they rush to the flight entrance. If the colony inside the hive has not yet managed to restore its normal life, and is thus unable to provide a reliable guard for its flight entrance, the robbers, being unrepelled in their invasion by the hosts, bravely break into the nest and, stealing the hosts' honey, fly out of the nest through the same flight entrance, taking the honey with them.

Each time the robbers return to the nest, their number is greater than before. Then the colony under attack seems to wake up and begins fighting. The hosts now repel the robbers as their enemies; they do their best not to let them in and attack the invaders by using their stings.

If the attack of the robbers is stronger than the response of the guard near the flight entrance, the invaders can break the hosts' defence and assault the nest. Now the war proceeds inside the hive. During the battle, if the might of the attackers is stronger than that of the defenders, the one to die first is usually the hosts' queen. Mother-

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less, the hosts abandon all resistance. They now have nothing else to do but surrender to the invaders.

In a colony which has been robbed and weakened in its struggle against its enemies, which has lost its queen, all instincts are suppressed; all, except one—that of self-preservation. The bees which have survived after the struggle have neither the forces nor the energy to rear a new queen and to start a new colony. Like war-prisoners, they obey the will of the conquerors. They fill their honey stomachs with their own honey and carry it to the nest of their enemies. And it will be the enemies' nest where they will remain. This colony has completely stopped its independent existence.

But the tragedy does not end here. Excited with their easy prey of honey, the robbers now attack their other neighbours even more. There is no obstacle to stop them in their assault of the honey treasures belonging to other colonies. The latter are paralyzed with terror, many bees die in their life-and-death battles with the robbers. The colonies which are not strong enough to repel the invaders are robbed and ruined.

The noise made by the robbing bees, the aromatic road laid by them in their flight during which they secrete strongly smelling substances, the strong aroma of the honey carried by the robbers—all this excites other bee colonies. Now, excited and eager, they also rush along the “honey route” paved by the others, and they also follow the track to get their share of prey. Robbing now spreads to infect the entire apiary.

It is much easier to prevent the bees from robbing than to fight it. When robbing takes the shape of assault, to quench it is very difficult, and sometimes even impossible.

Bees, invading the nests of others, may spread any infectious disease which they may be carrying on their bodies. But it is more common that the invaders get infected themselves by drinking infected honey or coming in contact with strangers' nests and foreign bees, thus bringing infections to their own home.

Bee robbery is an extremely hazardous evil. But its consequences may not be so dramatic if the beekeeper observes the following rules:

- do not open the nest completely, especially at the time when there is no honey harvesting;

- to interfere in the colony's life only when absolutely necessary;
- to keep the flight entrances open to the extent appropriate for the flying might of the colony;

- not to drop even a single bit of honey when withdrawing it from the hives;

- the combs with honey should be carefully hidden from the bees;

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- constantly to see that the nests always have large stores of honey;
- always to bear in mind that feedings make the colonies strongly excited and attract robber bees, it is much better to replenish the feed at night or during non-flying weather.

The robber bees more frequently attack weak colonies, as well as those infected with nosema disease, varroatosis, braulesis, or colonies without queens or with weak queens who fail to defend and guard their homes properly.

If the beekeeper learns the specific features and tiniest details of his bees' behaviour, if he treats them skillfully and interferes only in their best interest, never disturbing their peace and quiet, the bees will ever happily brood and yield him plenty of honey.

To be able to comprehend the specific features in the life of the bee colony, to understand well all aspects of its activities, to master the secrets of manipulating its instincts for the benefit of the man – this is one of the most important tasks of the beekeeper. Herein lies the main secret of success with bees, the fundamental basis of all practical beekeeping.

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D

uring the year, the bee colony undergoes qualitative changes chiefly because of the change of seasons, the phases in the development of the plant kingdom, the actual conditions of the bees' life, and the physiological state of the colony. While nature experienced its winter dormancy, life processes in the bee colony were respectively retarded. When the plants faded in autumn, the bees' links with the outside world cease to exist. By and by, all work in the nest was gradually stopped. The colony went on living only because of its instinct for self-preservation. All its activities were then concentrated on living through the winter and conserving its forces and energy.

During the course of evolution, honeybees developed an extremely valuable biological trait—when the cold time comes, they gather together in crowds, stick to their honeycombs and make up the so-called bees' cluster.

But as soon as the winter day starts to get longer, the sun begins to shine brighter and longer, and the air temperature in the daytime starts to exceed that of the night, the bees immediately feel this change. A certain note of joy will be more and more prominent in the voice of the bee colony. Before this joyful awakening, when in their winter dormancy, the bees were hardly audible, and it was only their quiet smooth hum which could be heard, as if there were some distant forest sending its soft noise. Now their hum becomes stronger and more persistent and powerful, as if coming from somewhere much closer than before. The tone of the colony is improving.

The bees, which used to occupy vacant cells, now gradually leave them; the middle of their cluster gradually gets softer and looser, its volume somewhat expands. The bees begin to show more concern and care for their queen, they bring her food more frequently and insistently. The queen now acquires a retinue. The instinct of reproduction awakens in the colony. The empty honeycomb cells in the middle of the nest are now carefully cleaned and polished; they are being pre-

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pared for the future brood. The queen begins laying eggs. As soon as the first egg is laid, the life of the colony changes even more obviously, the tone of the colony again heightens.

And when one will feel the approach of spring with its smells and sounds, when beneath the snow cover there can be seen plants returning to life again, when the birds and beasts begin their time of mating games, the nests of bees by that time will already have gotten much of their brood. For the embryos inside the eggs laid by the queen to be able to develop normally need a certain favourable medium, and most importantly a high temperature (at least 32 °C). And it is this temperature that the bees provide.

Honey as a source of heat. The heat that the bees need is produced by the colony itself, and the source of heat energy, a peculiar kind of fuel, is their honey. The main component of honey is glucose, which is the basic material for providing energy. As soon as glucose gets into the bee's organism, it is immediately absorbed by the blood. Other carbohydrates, affected by enzymes and other compounds, decompose into more simple substances. As a result of biochemical processes, heat energy is produced. Honey is extremely rich in calories: 1 kg yields 3150 calories. But the energy capacity of honey is not exhausted by its high calorificity alone. To be able to create and maintain the high temperature required in the nest, the bees must consume much larger quantities of honey than they used to do before.

Beebread—the “bread” of bees. With their increasing consumption of honey, the bees also expand their usage of beebread. The basic component of the latter is pollen, which the bees collect from stamens (the male generative organs of plants).

Flower pollen is rich in proteins which are used by any living organism as formative material to build its body. The proteins in pollen are chiefly in the form of albumens and amino acids which are the most easily absorbed by the bee's organism. Flower pollen also contains fats, mineral substances, enzymes, carbohydrates.

However, pollen as such is not yet the food that the bees can consume immediately. It is a kind of flour with which the bees prepare “bread” in their nest. Collecting the pollen, they wet it with their saliva and nectar, and storing it in the honeycombs, they enrich it with honey. As a result, the pollen, so treated, seems to become a kind of kneaded dough. The yeast fungi of the plant pollen interact with the enzymes of the bees to induce some biochemical processes encouraged by the heat and moisture of the hive. As a result of the enzymatic reactions, namely, protein-carbohydrate hydrolysis, the pollen turns into

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During the main honey flow.

the so-called beebread, or the “bread” of the bees. Both in its flavour and consistency, beebread resembles fresh, warm rye bread. The phytoprotein of the pollen splits into amino acids; the cellulose of pollen grains decomposes; all this increasing the digestibility of the food. The lactic acid formed from the decomposition of carbohydrates possesses strong conserving properties, which allows for beebread to be preserved fresh for a long time.

Beebread is mainly used to prepare the forage for larvae and to feed the bees nursing the brood and building the honeycombs. But, without getting the beebread, young bees would never be able to become physiologically mature and strong. If provided only with normal protein nutrition, by the age of five days the bees’ bodies would contain 60 per cent more nitrogen. The glands secreting royal jelly, wax, and other substances would not function if the organism of the bee does not receive the beebread. The latter is badly needed by adult bees as well. When deprived of beebread, the bees’ pharyngeal glands stop functioning and the nectar cannot be fermented properly.

When drones suffer from a protein deficiency, the activity of their sexual glands diminishes. If beebread is scarce in the nest, the bees may expel the drones even in the middle of summer.

Queens, when reared by bees in the scarcity of beebread, prove to be of low fertility, and it is a frequent case that the bees replace them more quickly than usual. Bees require beebread even during winter

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dormancy. If there is no beebread in the nest, they get nervous as early as December. A strong bee colony can consume as much as over 34 kg of beebread within a year.

When bees consume large quantities of carbohydrate- and protein-rich forage (during the reproduction period), their metabolic processes speed up to restore their forces depleted during winter, to improve the function of their endocrine glands. The bees begin producing royal jelly to feed their larvae with.

The jelly of the bees is the secretion of the pharyngeal and maxillary glands. It is a product extremely rich in hormones, vitamins of the B group, proteins, folic and pantothenic acids, as well as in other vitally important acids. Queen jelly contains all components necessary for the growth and development of the embryo. The fact that this jelly is of exceptionally high nutritional properties, is testified by the growth rate of the larvae. Within the first six days of a larva's life its mass increases by over 1300 times!

With the increasing quantity of the brood, the amount of carbohydrates and proteins consumed also increases. The greater the quantity of the forage used, the greater the number of bees the colony can rear. *The growth of the colony is directly proportional to the amount of the forage consumed.* A colony consuming much honey will produce it in great excess.

As soon as the brood appears in the nest, the colony passes from a state of almost complete dormancy into one of action. Whatever the colony does now, it is guided and governed by its instinct of reproduction.

The queen during these days does not lay many eggs (only 20-30 per day). The eggs are laid in the warmest part of the nest, in the very middle of the bees' cluster. At first, the queen lays the eggs only in one honeycomb, on both of its sides. Gradually, the egg-laying increases and takes over new areas of the honeycombs. Respectively, the volume of work for the colony also increases.

The premature emergence of the brood. There are cases when reproduction begins much earlier and ahead of schedule not due to the awakening of nature but as a result of some other factors which most frequently exert a negative influence on the bees.

If the bee colony started the winter weak, i. e. with few members in it, now, in the dead of winter, so as not to perish from the cold, each of the colony members will have to expend much more energy and use considerably more forage than members of strong colonies. This will result in their premature exhaustion, their physiological ageing and the shortening of their life span.

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Since the bees consume larger quantities of forage, their stomachs accumulate ever increasing amounts of undigested matter. The bees cannot clean their stomachs from such a build-up of undigestable food in winter (they do this during their first spring flight away from their nest), they get so overfilled that their stomachs fail to absorb new undigested food any more. Their situation becomes critical. When the brood appears too early, there is always a danger of dysentery.

When her stomach is overfilled, a bee cannot consume as much food as she needs and, consequently, to produce the amount of heat energy she requires. Then the bee leaves the cluster to get rid of the excrements. The bees frequently do this even in their nest: on the planes of the frames, on the honeycombs, on the walls of the hive, especially on the front one while on the way to the nest's exit. The bees with their stomachs emptied usually return to the cluster and go on living until spring. But there are quite a few bees with their stomachs overfilled, which get weaker and virtually sick; they break off from the cluster and drop to the bottom, wherefrom they cannot return to the nest, getting chilled and finally perish. The conditions inside the hive become very severe. The bees die daily in ever increasing numbers. The colony is dying out.



Collecting nectar.



On a comb.

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Even a strong colony may find itself in this situation. If during their winter season the bees have low quality forage (they feed on honeydew, collected from tree leaves, or soured due to the dampness in the hive), their stomachs can get prematurely overfilled and upset. If their nest is often attacked by winds, the bees, in their attempts to warm themselves up, have to process more honey for heat energy. As a result, their stomachs can get overfilled earlier than normal. Fighting for its very existence, the colony comes out of this critical state by increasing its parental care of the young.

The instinct of reproduction becomes prematurely strong, though it may seem very surprising, even in colonies whose food reserves are depleting or are situated far from the cluster and are hard to get to, or in cases when the honey becomes granulated. Normally, the bees cannot feed on granulated honey. They can only lick the surface layer of liquefied honey in-between the crystals. When starving, the bees get physically weaker and their life begins to be extinguished. The buzz of the starving colony gets duller with every day; the colony does not respond to one's slight knocking as fast as before, the reaction is very soft and mild, like the sound of rustling dry leaves still clinging to the tree. In such a state, the colony has no power to rear the brood. It must be helped and saved. The colony is given proper food: good honey, dough of honey and sugar, or syrup.

Now, the combs with honey in them are placed at the edges of the cluster, the empty honeycombs having been removed from the nest or pushed off. If the nest has no ceiling but is covered with a cloth, one lays across the frames some little rods at least 8 mm thick to facilitate the bees' passage to the combs with honey.

To improve the conditions even more, right on the rods of the frames above the nest, a comb full of honey may be placed. To make all of the cells accessible to the bees, little racks are installed beneath this honeycomb.

When there is no honey in the combs, the colony may be given honey-sugar dough. To make this dough, the granulated honey is melted in a water bath (the pan with the honey is placed in another pan with a larger amount of water, and both of them are heated). With the honey crystals completely dissolved, the honey is kneaded with sugar powder, as much of the latter being added until the dough is sufficiently thick. The dough is regarded ready for feeding when it practically keeps the shape you give it, and when tiny drops of honey begin to dance on its surface. The proportion of honey and powder is one to four. The dough is rolled up to make a big flat cake, placed over the nest and covered with waxed paper or cellophane. Sometimes a more calorie-rich food is used, namely a dough made of honey-

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sugar-pollen. In such dough the pollen comprises one fifth of the total mass.

Starving bees can also be saved with sugar syrup. The latter is poured in honeycombs placed at the edges of the cluster or served in ceiling feeders (the holes of the latter are arranged across the frames). One liter of syrup is sufficient to feed a colony of average size for about a month.

Queens may begin their premature egg-laying due to nosema disease, varroatosis, and all kinds of disturbances. The colony begins consuming more food if its queen dies, if the heat in the nest is excessive, or the air exchange is insufficient.

The nosema disease, or infectious dysentery, is caused by a microscopic parasite called nosema. It should be noted that the spores of nosema are spread almost universally and can be found practically in every bee colony. But nosema disease strikes only such colonies in which the conditions favour the development of this parasite.

The most favourable environment for this disease agent is in the stomach of the bee suffering from non-infectious dysentery. But that alone is not enough to initiate the disease. For the nosema spores to mature they need a sufficiently high temperature (up to 32 °C). This temperature is exactly the one observed in the nest when the brood appears. The parasite can also flourish greatly due to the damper environment.

The nosema spores begin their speedy reproduction. Overfilling the bees' stomachs, they enter into their hemolymph (blood), and via blood circulation they are carried to other organs and tissues of the body. The bee gets seriously ill.

When the number of sick bees increases, the cluster loses its compactness. Now the buzz from such a nosematic colony is full of alarm and disharmony. The colony's response to one's light knocking on the hive walls is not immediate and dull; when disturbed, the colony does not quiet down for a long while.

Many bees leave a nosematic nest to sit on the flight board and the front wall of the hive. Some of them, having defecated right there, try to return to the nest; others fall down and crawl all over their winter abode. The life in many of them is extinguished while still in the hive; dead bees accumulate on the floor; the lower flight entrance, if it is small, gradually gets packed with dead bee bodies; the ventilation inside the nest becomes insufficient and finally stops altogether; the build-up of dead bees increases. If the sick colony is not immediately helped, it will perish during winter hibernation or become very weak soon after its cleansing flight. And the first aid rendered to such a colony is intended to help it to fly around and to find a new nest.

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The bees which badly need to empty their bowels can do it in their cleansing flight even when the snow cover is strong and thick, let alone when the weather is quiet and sunny and the air temperature in the heat of the sun reaches at least 8 to 10 °C.

The hives with sick colonies are placed on boards, poles or other supports, so that they face the southern side of any structure, as close to the wall as possible. To warm up the air layer at a level of 1 to 1.5 m above the earth, within which the hives are, the plot in front of the hives, which is 3 to 5 m wide, is covered with tar paper or roofing material. The black colour of the latter, intensively absorbing the sun rays, is warmed up and then gives the heat up, thus improving the conditions for the bees' flight around. To speed up the warming of the nests and the very cleansing flight of the bees, the roots of the hives are removed, as well as the warming quilts, and the nests are covered with dark pergamine.

Upon the flight the nests are dismantled. The honeycombs with the brood are left in the nest, those with low-quality honey or without any honey at all, likewise the ones stained with excrements, are replaced by clean ones containing reserves of good honey and bee bread. If no comb honey is available, the bees receive sugar syrup with fumagillin.

The syrup supplied to the bees is prepared in the proportion of 2 parts sugar and 1 part water. Sugar is dissolved in boiling water. The syrup received is cooled to 35-37 °C, poured into the combs, and served to the bees, at least two frames per each colony. The frames are put in the middle of the nest, the syrup inside them being carefully covered. Then the hive is taken back so that during the cold weather the bees will lose their reflex for the place of their compelled flight, and their new instinct would develop now at the permanent place.

Varroaosis-stricken colonies also begin rearing their offspring ahead of their usual time. When wintering, these bees behave nervously, though in appearance everything may seem to be normal. In reality, the layer of the dead bees is increasing daily. The sick colonies can be helped only after their spring flight, if they are only able to survive that long.

Another reason for the premature appearance of the brood is the bees' excitement caused by rodents.

A colony which is approached by a single mouse gets extremely excited, bursts into alarm and noise, protesting against the enemy's presence, but since all of them are together in one cluster, the bees are incapable of doing anything. The mouse takes advantage of their weakness, and swallows their food without any punishment; it also eats up

The Queen Lays Her First Egg

only the dead bees but the ones which are still alive in the periphery of the cluster (at its bottom or sides). The mouse digs a passage for itself into the combs where it moves its bowels. The atmosphere inside the hive becomes unbearable. And the colony, which was enjoying a calm and comfortable wintering, within this last, and perhaps the most difficult period of its life, can suffer the heaviest losses.

The presence of mice in the hive and nearby can be detected by their excrements, their specific smell, and the destroyed bodies of dead bees. To know for sure which hive the mouse has got in, the layer of dead bees is removed from the hive through the lower flight entrances, using a specially curved wire. The layer so examined will show exactly where the rodents live.

To kick the mouse out of the hive is a rather difficult task. It is much easier to trick it to come out and then to catch it there. Rodents love little bits of fried lard or bread soaked in sun-flower oil. Supplied with these odoriferous products, mousetraps are placed near the holes through which the mice had managed to get in.

The stronger and longer are the effects of negative factors upon the colony, the more active will be its response to these factors. Finally, all this taken together will lead the colony to a critical state. Its instinct for reproduction gets sharper as a response to environment in its struggle for existence.

Upon starting to rear its new generation, the colony becomes less conscious of the surrounding dangers, to some extent. Before the bees get completely weak and leave their nest for good, they will still be able to raise some offspring which will continue the colony.

The same biological law—the quest to preserve oneself in one's offspring—can be observed throughout the entire living world. Thus, on a dying fruit tree a great number of fruit buds will suddenly burst into abundant blossom. One can witness the same response in a tree which, having not borne fruit for a long time, bursts into budding and fruiting upon being disturbed.

When the instinct for reproduction is manifested due to the effects of a natural life cycle, i. e. in its proper time, the qualitative state of the bee colony does not get worse, as compared with its state at the onset of winter dormancy. It is true, that during wintering each member in such a colony may get weaker and older, but the organs in each bee still preserve their physiological youth, i. e. they are capable of rearing the brood and of gathering the forage. The stomach in these bees does not get overfilled since their dormancy was much longer and they did not consume so much food. The increasing amounts of honey and beebread they use now as they begin rearing their offspring is not harmful for such a colony. The critical state discussed above (an

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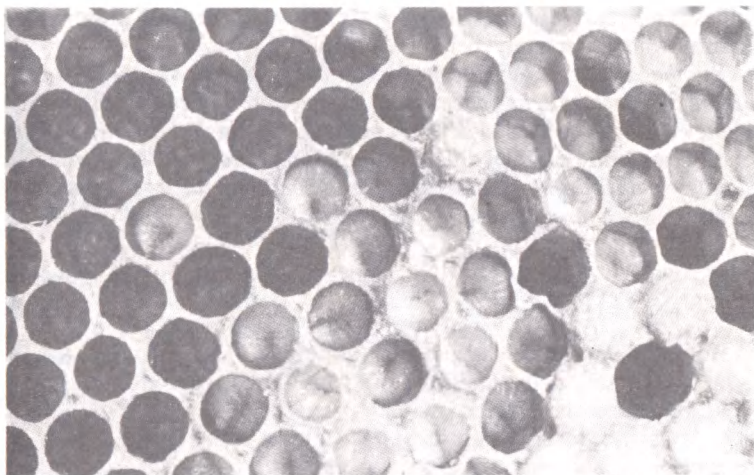
urgent need to move the bowels), is practically unknown to them. Beekeepers say about such colonies: "Whatever condition they are in when they enter the winter, they are the same as they emerge from it."

In this way, the qualitative state of different bee colonies may vary by the end of their wintering. Some of them can survive the winter conditions well and will need no helpful interference. They will be quite able to survive until that warm day when they will make their first flight, which is called a flight of cleanliness. Others, which cannot withstand the wintering well enough, will, on the contrary, need some outside help. This help will be frequently very urgent. It should be noted that not in all cases will the bees which are given such help return to their normal state of calm and quiet, or that their reproduction instinct, which was so prematurely awakened in them, will be quenched or prevented from becoming manifest.

In the southern regions, especially in the subtropics, the bees can make periodical flights out of their hives during wintering. In these areas, their earlier awakened instinct of reproduction is regarded as a most favourable factor. The earlier work of the queens here is even encouraged, the queens and colonies receiving special feeding of protein-carbohydrates. Thanks to such feeding, by the onset of their first productive harvesting, the colonies have already accumulated considerable reserves of young bees and of brood. This practice is rather popular in the south of this country, in Rumania, the USA, and in other countries, too.

There are many factors which disturb the calm state of the bees wintering indoors and provoking their premature reproduction. But the same factors will exert an essentially lesser effect if the bees spend the winter under natural conditions, outdoors. Then the air in their nests will always be fresh, the temperature will be uniform and favourable; thus, there will be no oversaturation with water vapours and other products resulting from the bees' life activities (the external air is known to be dehydrated by frost, the gas exchange in the hive proceeds faster in the open air). Under these conditions, the honey, as a rule, does not turn sour and almost never crystallizes. The colony does not have to face the dangerous state when the cluster may disassemble and the bees begin moving their bowels inside the nest. They can purge their stomachs on more or less brighter days which are rather frequent during the second half of winter, even in the northern regions of the European USSR and in Siberia. Hunters and wild-honey farmers have witnessed many times how the bees make their cleansing flights in sunny weather with minus temperatures in the shade. Sometimes the bees move their bowels without flying around, they do this on the external side of the tree hollow, near its entrance

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Larvae before capping.

(in the vicinity of the flight entrance) if the weather conditions do not permit them to fly out of the nest to satisfy their urgent need. But such cases are extremely rare.

When living under conditions in which this insect species evolved, the natural course of the bees' life does not suffer so badly as often happens when they are placed under different conditions: imprisoned inside stuffy cellars, damp vaults, or badly ventilated winter premises, the bees find their life disturbed.

The period of dormancy or rest is the one that chiefly determines the outcome of the entire wintering period. With bees living under natural conditions, the dormancy lasts longer, and the onset of egg-laying is more delayed. The instinct of reproduction in such bees is mainly excited by longer daylight and their awareness of the pre-spring breathing of nature. This is precisely the reason which compels more and more beekeepers to provide outdoor wintering conditions for their bees, and this tendency is gaining popularity not only in temperate regions, but also in those of cold climate.

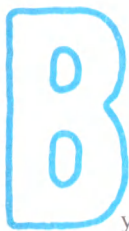
The premature manifestation of the reproduction instinct in bees (an extremely early egg-laying by queens) is especially undesirable, though it is, indeed, a natural reaction of the colony in its struggle for existence. Even if this colony survives, after such wintering it will be enfeebled, its young bees will be physically weak, and the beekeeper will have to spend additional time and effort, while such bees will be of no practical value for him any more. The losses suffered by the beekeeper when his col-

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onies get weaker during wintering are much worse than those which result from completely perished colonies.

So, the last period of wintering – from the appearance of the brood until the first spring flight – does not differ much from the bees' rest period if they spend the winter under the conditions in which this species of insects historically developed. For bees to winter indoors is unnatural, it is badly complicated by several negative factors, and, as a result, its outcome is often unsatisfactory.

The Colony Is Governed by the Instinct of Reproduction



y the end of wintering, whether having wintered indoors or outdoors, the bee colony is in a more difficult state than at any other time. The bees have aged during the winter, their stomachs are filled with undigested food remains. Furthermore, the brood in the nest must be properly fed and kept warm, but at this time it occupies a considerable area of all honeycombs. In view of all this, the bees have to consume much more food than before, though then their stomachs were almost empty. Now they do not conserve their food any longer and consume particularly huge amounts of beebread. Now the latter is vital not only for feeding the larvae but for themselves, too. If they receive insufficient quantities of beebread, the bees spend the protein of their own organism; this weakens the functioning of the glands secreting jelly, and the bees, as a result, get exhausted and aged more quickly. With sufficient quantities of protein food in the nest, the bees' organisms do not age prematurely.

Due to the increased consumption of protein food, the back section of the bee's stomach, where by this time many undigested substances have accumulated already, is getting more and more filled up. The colony, with every new day, approaches the critical line beyond which it will be no more able to fulfill its functions. The critical situation does not strike such colonies which winter in peaceful surroundings and have sufficient reserves of good-quality forage. They will survive well throughout such long winters which may last up to seven months. And after this long period of dormancy, the bees will live until their first spring flight.

The day the bees wait for all winter. The bees wintering outdoors are helped to enjoy their orientation flight right on the very first pleasant day. To prepare for it, on the eve of the day when the weather is promising to be fine and warmer, the gates of the front walls of the hive are removed as well as all the snow still remaining there.

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The flight of cleanliness. The spring flight. How long have the bees been waiting for this, how many efforts had they to sacrifice to be able to live until this day when they can leave their winter prison and once again enjoy their native elements such as the wide open space, the bright light, the awakening nature!

As soon as the first sunny ray has broken into their nest through and near the upper flight entrance, the entire cluster gathers together; as soon as the hive receives the first fragrance of spring and sunshine, the colony immediately responds to this magic touch of nature. First, one little bee peeps from the flight entrance, then another inquisitive bee, followed by a third one. Then all three make some timid first steps, and stop as if blinded by the rays of the spring sun. Rubbing their eyes with their front shanks, they move their little antennae from right to left, look around as if still hesitating to accept the reality they see, and then they fly up into the sky. With their little heads turned towards their nest, the bees make timid, slow movements, as if having forgotten their skill of the last year, and then they circle the hive, making several quiet loops above it. Thus they try to memorize the location of the hive and how it looks. After that, they fly somewhat farther and higher, making wider circles, crossing them and drawing fancy figures inside them. It seems as if some living strings have been stretched high up in the bright sky and are now singing there!

The bees which were the first to leave the hive are now followed by some others, they fly in twos and threes, and finally in whole scores. It will only take them a couple of minutes to leave the flight entrance in huge masses. And, with their spring flight in full swing, the entire area seems to be transformed. The air all around is filled with the buzz of many thousands of bees, their noise is full of joy, excitement, solemnity; it seems to have incorporated in itself all other sounds of spring. The air looks so beautiful, as if some living net weaved of wonderful threads has been hung by someone. The little cells of this magic net are now coming closer to one another, overlapping and forming a dark cloud. At the next moment the cells are expanding to such an extent that the net looks broken in pieces, each of them going to live independently. And in a brief instant everything is swept somewhere aside only to return immediately to the previous position in no time at all.

During their flight of cleanliness, the bees move their bowels. Upon emptying their stomachs, they continue flying for some time, as if greatly enjoying their first holiday of spring. Then they return home, encountering on their way new groups of bees which are eagerly awaiting their turn to take part in the spring festival.

The spring flight lasts 20 to 30 minutes. In apiaries where the hives

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impossible to avoid, and it also hinders the air flow into the hive. All this greatly excites the bees. If the flight entrance is not opened at once, the excitement of the bees may reach its utmost. If the colony had difficulties during wintering, the bees would begin moving their bowels right in the very nest.

The hives are usually arranged with their flight entrances facing the south-east. With this set-up, the sun-lit walls of the hives are sooner warmed by the sunshine which can thus reach inside the flight entrances much faster.

As a rule, the colonies rear the brood in the direct vicinity of the flight entrances through which the nests receive their fresh air (all processes of metabolism in the developing organisms can proceed normally only in the steady presence and access of oxygen). Both of these two factors, namely, the atmospheric heat reaching the nest through the walls of the hive, and the sun-heated air flowing through the flight entrance, positively influence the entire course of the colony's life, and, in particular, the growth of the colony.

Since the plots near the houses are often small, the hives in the apiary are usually set close to one another (at a distance of 1 to 2 m). In such cases, the flight entrances are not opened in all the hives at the same time, but only in every second or third hive at first. The first colonies to be let out are the most excited ones. With their orientation flight coming to a close, the rest of the colonies are permitted to fly out.

When several colonies fly around simultaneously and in close proximity with no good landmarks to help them orient themselves, not all of them will return to their nests. Some of them will enter foreign colonies.

Disturbed by their removal from the winter hut, colonies, particularly those which are strong, start their orientation flight in huge masses. Many bees may sweep up into the air even without looking around or memorizing their own home place. Such bees, as a rule, upon moving their bowels, join the bees of another colony, which often happens to be their neighbour and at the moment is also engaged in a fierce orientation flight. After such a joint flight, the bees do not return to their own home, but to that of the neighbours. As a result, some colonies become weaker, others gain additional strength, but neither outcome is very desirable.

Such wandering of bees is dangerous because it may spread infectious diseases (nosema disease, varroatosis, etc.) all over the entire apiary.

At this time weak colonies, especially those whose wintering was poor, may frequently leave their nests for good.

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Bees can be removed from their winter huts in the evening, after sunset. Natural light, as a rule, excites the bees, but in the late hours of the day there is no light and one may open the flight entrances in all hives at once. Even if the bees may partially cover the flight board in excitement, the darkness and cool of the night quickly calm them down and they immediately return to their nests.

The advantage of removing the hives in the evening rather than in the day-time is that after night the colonies leave the hive for their orientation flight one by one, not from all hives at once, they do not wander about in the air (all of them return to their home hives). In case the weather remains bad for a couple of days and the colony cannot complete its flight to move the bowels, the fresh air now, when the colonies are outdoors, will not worsen their state but only alleviate their conditions.

The evening removal of bee hives is often practiced out of necessity: for some reasons, one may sometimes fail to remove his hives from the winter hut in the morning. If the bees' wintering was not good, it is not desirable to set the hives for the night because the bees may start moving their bowels right there in the hives.

The bees begin their life of work. While the flight is not yet over, one can see some bees returning home with heavy loads on the flight boards and near the flight entrance. Having flown over the place before the others and upon examining the surroundings, these bees have already detected some snowdrops, coltsfeet, nut tree, sharp-leaved willow, as well as other spring primroses. They have collected their first drops of the fresh and fragrant nectar, small lumps of yellow pollen, and have brought all their treasures home. Some bees were smart enough to gather water in sun-warmed places. Meanwhile, others began cleaning the nest. They are carefully taking away all possible rubbish, dead bees and the like, and throw everything somewhere further away from their home. Not a single instant is wasted!

Spring has awoken other insects who live in communities and solitarily, and they are now also active. The bees' instinct for guarding and protecting their home, forage and offspring is now awoken, too. Like all other natural dwellers, bees have their foes and wreckers.

During the very first moments of their orientation flight, the bees arrange a watch and some guards near the flight entrances. The little "sentinels" carefully study the bees returning to the nest, especially those whose behaviour differs from that of their own. If all of a sudden a bee arising the sentry's suspicion makes her appearance near the flight entrance, she will be thoroughly examined, felt from all sides and her smells will be analyzed. A bee from their own nest will be

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allowed to enter, while a stranger will never be let in. If an alien bee has reached their nest by mistake but begs to be accepted by their community, the sentries will let her in to become an equal member of their colony. But if a bee from the outside ever dares breaking in to steal their honey, she will be caught and immediately killed, if she fails to flee.

The spring flight seems to refresh the bees' organism, as if intoxicating them with the vitalizing elixir of cheerfulness, courage, and energy; their maternal and reproductive instincts, as well as other vital instincts, such as the guarding of the nest, keeping it orderly and clean, or that of procuring forage, all of them have revived again by spring.

The joy of spring is not enjoyed by all bees equally. It may so happen that during the first orientation flight, not all bees leave their hive. Many of them may fall down from the flight board, trying to fly up into the air, and then crawl about with their wings bristling, as if they are twisted and wrenched. Such a colony is stricken with acarine disease which is a very infectious disease carried by a mite which lives in the bee's respiratory system. The mite penetrates the chest trachea and exists there, feeding on the bee blood.

Sometimes bees start their spring flight with their abdomens extremely swollen; then they reluctant to fly and the flight is long and weak. All these signs show that the colony is infected with nosema disease. In such a colony the flight board and the front wall of the hive above the flight entrance are stained with excrements already during wintering.

When the beekeeper suspects his bees to be infected, he selects groups of 50 bees each, places them into little boxes, packs them carefully and inside each box puts a note with the number of the colony and a detailed description of the sick bees' behaviour. Then the boxes are either mailed or taken directly to the nearest district or town veterinary-bacteriological station.

Some colonies do not feel like flying out for a very long time, but when they do, their flight is weak and unsure. Only separate bees join in the flight but even they do not fly far. There is a feeling it is not a colony but only a handful of bees. No job seems to attract them. Under such circumstances, the beekeeper would open the nests of such colonies to detect the reason for their strange behaviour. It is more frequently found that such colonies are exhausted and physically weak from starvation, having lost almost all of their members. The starving bees, if they are still capable of growing without outside help, are given frames with unsealed honey or warm syrup. Extremely

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weaken bees are grouped together (two or three in one group).

When the colony does not feel like flying and some of the bees are running about the flight board and the front wall of the hive as if in search of something or someone, it means the colony's queen died during wintering. The motherless bees, if there are still many, are provided with another, reserve queen, or they may be added to a neighbouring colony that is normal.

During the spring flight, the bees do not show openly if they are infected with varroaosis. The causative agents – external mites – can be found by the naked eye on the bees, the brood, or on the rubbish at the hive floor. The numbers of mites discovered on the dead bodies of bees and on those still alive will help to determine the degree of infection within the colony, so that the beekeeper can take urgent steps to treat his bees.

The bees may be freed from these jobs. After their first spring flight, the colony intensifies its care and concern for the offspring. Now it is the leading motive in all of its behaviour. The care of the offspring is an inherited feature. It was appeared and developed during the evolution of this species to preserve its further existence.

For every colony, after its wintering the days of life which remain are already counted. The colony does its best to speed up the rearing of as many new bees as possible so that they will be able to continue to exist. The new bees must accumulate their weight as intensively as possible; the new generations must be born strong and healthy. To reach these goals, the colonies try to provide their young with most favourable conditions from the very first days after the spring flight.

No matter how well the wintering is endured, there are always some dead bees in the hives, those which died from old age. There is always rubbish of all kinds, and occasionally some rotten beebread. In the very first minutes after their spring flight, the bees begin cleaning their nest and home. And their jobs are actually gigantic! To be able to remove the spoiled beebread from the honeycombs, the bees have to gnaw the cell walls out, to drag the beebread lumps away and take them beyond the hive.

And just to think of the rubbish on the hive bottom and in the empty honeycombs of the lower framework! This rubbish can cause many serious problems for the colony. It contains pieces of cocoons and of rotten beebread thrown out by the bees before their flight. And these pieces include protein, and fat, and mineral substances, and what not! There are also crystals of honey which dropped from the nest.

With the higher temperature and humidity which are typical for the

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Bees with wax scales. They are building combs and capping the honey.



A mite on a drone larva.

bees' nest, the hive rubbish creates an extremely favourable environment for parasites, pests and hazardous microflora. The bee colony seems to feel this danger as if properly warned by its instinct of self-preservation. The bees clean their nest by throwing away every little bit or tiny crystal of hive rubbish, though it costs them great efforts. If one frees them from this hard work, the bees may use their energy for something much more useful.

The honeycombs with spoiled beebread are removed from the hive. If not, they will still attract the bees for quite a long time. The cleaning bees will spend their time and efforts on a job which is no longer very important for the colony, because there are others to be done immediately. Besides, such honeycombs will restrict the nest area at the moment when each and every cell of the combs is so vital for the colony's spring growth.

But the effective area of the nest becomes even more limited when one does not remove honeycombs with excrements, and particularly those affected with dysentery. If the former may still be used by the bees to some extent, the latter are of absolutely no use to the brood, because the bees would never place either the nectar or the pollen they collect in these cells. These honeycombs would be avoided by the queen, too. Thus, they will turn into a dead zone within the nest. And if, above all, this zone is infectious (containing agents of diseases), it may contaminate still new generations of bees. That is why it is ex-

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tremely important to remove such dysenteric combs immediately. They should be replaced by new ones, so that the colonies might be moved into clean hives.

If a colony is sick, sanitary measures taken alone are not sufficient. The sick bees must be treated with medicinal preparations.

In recent years, bee colonies infected with acarine disease have been treated with an effective drug called tedion. One or two tablets of tedion are put on a metal plate, burned up and introduced into the hive through its lower flight entrance. Then the hive is firmly closed. The treatment is initiated in the evening, after the bees finish their flight. In the morning the flight entrance is opened. Ten series of such treatments, effected every other day, will completely cure the bees from acarine disease.

Bees infected with nosema disease are treated with fumagillin (a Hungarian water-soluble antibiotic). One flask of this drug (20 g) is dissolved in a small quantity of warm water and mixed with 25 liters of sugar syrup. The mixture is given in quantities of 250 to 500 g per colony daily for two or three weeks. To reliably cure one colony, it is necessary to use at least five liters of such syrup.

Colonies badly infected with this disease receive syrup of high fumagillin concentrations. A flask of the drug is dissolved in 15 liters of syrup. The latter is not only given directly to the sick bees but they are also sprinkled with it, likewise are the walls of the hive and the nest. The duration of the treatment and the doses are the same.

To combat the nosema disease, it is also effective to apply sulfadimesine in doses of 1 g per 1 liter of sugar syrup. The drug is at first dissolved in 50 ml of warm water. The dose per one colony is 0.5 liter, three or four times in four to five days.

It is also possible to use sulfadimesine with sugar powder (1-2 g of sulfadimesine per 20 g of powder) for spraying the honeycombs with bees inside some three or four times every four or five days.

Bees infected with nosema disease can also be cured by alcohol infusion of wormwood. The infusion is prepared in the following way. Young leaves and shoots of wormwood are ground up, placed in a glass flask (not more than half filled) and then filled to the top with ethyl alcohol or vodka. After three days the infusion is ready.

The healing food is prepared of 0.5 liter sugar syrup and one tablespoon of wormwood infusion. The drug is administered to the bees three to four times every five to seven days. The wormwood infusion has proved to combat the disease very well.

On the clean bottoms. If the bees dwell in multiple-storey hives, much rubbish accumulates on the hives' bottoms during winter. The dirty

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bottoms should be replaced by clean ones which must be prepared beforehand. The bottoms are replaced after the first spring flight when the bees return to their nests and calm down.

The procedure is as follows: one or two jets of smoke are let into the hive from a smoker if the colony is strong and the bees are close to the flight entrance. After two or three minutes, the hive is placed to the side and a reserve bottom is placed on its support. The storeys of the hive are separated from the bottom or the empty semi-framework by means of a beekeeper's chisel, if the colony spent the winter on a so-called air pillow. Then the hives are placed on a clean bottom. This job is made easier with the help of special hooks. With the hive uplifted, the hooks are placed beneath the bottom from its sides, and when returning the storeys to their place, the hooks are used to hold the lower storey.

The bottom can be replaced without placing the hive to the side if it is not heavy and consists of only one storey: one beekeeper separates the hive from its bottom and lifts it up while his assistant replaces the dirty bottom with a clean one. This operation can be performed in any weather and without smoke, even before the bees' first flight. The bees almost do not notice what is going on.

Thus, man can clean the colony's home of all its rubbish and of dead bees in just one brief minute, whereas the bees would need at least two weeks to accomplish the same thing.

The rubbish and dead bees are swept into a box, so that nothing remains on the ground, because any remains of rubbish may provide sources of infection and antisanitary conditions attracting foreign bees. Disease agents which may remain there may be brought into the nest together with the water that the bees are particularly fond of gathering from the ground at this time of the season. The rubbish may also contain mites of various kinds, and among them there can be some which eat up the beebread. These mites can also return to the bees' nest.

The bottom is washed with a hot lime liquor or a 2 per cent solution of caustic soda, both of which act as disinfectants. Then the bottom is rinsed with clean water, wiped dry and used to replace the bottom of another hive. If there is enough time to spare, it is good to dry the bottom in the sun. If there are suspicions of a possible nosema disease infection, the bottoms already washed can be burned slightly with a blowpipe. The dirty water after washing must be removed to a place (beyond the bees' reach). The dead bees should be burnt.

The replacement of the bottom provides for more hygienic conditions in the hive and improves the atmosphere in the bees' nest, favouring the colony's normal activity.

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If the bottoms are nailed to the hives, it is much more difficult to remove the rubbish. In such case the nests must be disassembled. And to perform this serious job, one has but too often to wait for warmer weather.

In one or two storeys? In addition to replacing the hive bottoms, it is also desirable to adjust the nests to the strength of the colonies. When preparing the bees for wintering, their nests are usually made larger than the bees can actually occupy; sometimes vacant honey chambers are installed beneath the storey. In early spring, when the bees are chiefly engaged in providing heat for rearing their brood, they need a considerably smaller nest.

If the colony spent the winter in both storeys of the hive, the upper one is separated from its back side by means of a chisel; then it is lifted up in such a way that the beekeeper can look inside both storeys. If the bees are inside both of them, though fewer of them occupy the lower one, they are left in the upper and lower storeys untouched. If the bees are mainly concentrated in the upper storey, the lower one is removed. The colony remains only in one storey.

The bees, which spent the winter in one-storey hives, prefer nests of the same volume they enjoyed before. The weight of food in such nests would be estimated "by hand", i. e. by lifting the hives somewhat up from their back, or "by eye", i. e. by looking at the nests from their top.

It is impossible to provide in a one-storey hive the same huge amount of food which one leaves to be consumed by a strong colony during winter. Therefore, artificial swarms receive additional quantities of food, since theirs are insufficient. To insert the additional food in the nest, the latter must first be disassembled, so that the depleted honeycombs can be replaced by new ones filled with honey.

An artificial swarm is considered to be in good condition, capable of living and growing, if at this moment its nest contains at least 12 kg honey and two frames of beebread. In such a nest the bees can find everything they need for themselves and their offspring for at least three weeks after their first spring flight.

When comb honey is lacking, the depleted food supply is replenished by sugar syrup. Experienced and careful beekeepers prepare as much as 40 kg of food as early as autumn to provide their strong colonies well. The bees consume from 12 to 15 kg of food during autumn and winter. Therefore in such cases, the beekeeper does not have to disassemble the nests in spring if he wants to assess their honey content. There is no need for this operation later either, because such huge food supplies are sufficient to last a colony

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throughout its growth in any kind of weather. Beekeepers in the northern areas of the USA and Canada also provide about 40 kg of food for their bees to last them through the entire winter; they do not think that so much food is excessive, because they expect to have at least 20 kg of honey and several combs with beebread by spring.

In the southern parts of the USSR, bees begin collecting pollen and nectar a month or a month and a half earlier than in the central and northern regions. In these areas the bees consume during winter reserves that may be some 6 to 8 kg smaller.

Thanks to the abundancy of food remaining in the nest, it has become possible to control and govern the growth of the bee colony. In the past, to provide for the normal development of the colony, it was vitally important to wait for fine spring weather on which depended both the secretion of nectar by plants and the bees' honey gathering flight. In our time, with the new technology in beekeeping, we do not depend so much on the early nectar plants and on the pollen ones.

The food reserves are of great importance vis-a-vis feeding the larvae. When the reserves are sufficient, the larvae thus receive much jelly, with poor food supplies, the amount of bee jelly fed to the larvae is much smaller, which badly affects the weight of the future bees, their fitness for work, and life span, too.

There is no other mistake committed in beekeeping as grave as leaving the bees without abundant reserves of food in spring.

A strong colony, well provided with food, does not need any help from the outside; one only has to peep into the nest itself so as to check if there is any mold on the terminal frames or stains of dysentery, or whether the beebread is in good shape. Any of these adverse factors may take place if the nests were not properly ventilated during winter. Such bad honeycombs are replaced by ones in good condition.

It will be much easier for the bees to preserve the heat in their nests if the beekeeper leaves open not two entrances, as was the case in winter, but only one. The upper entrance, which was used for winter ventilation, is now closed. The lower one is kept open only a small crack.

In such apiaries where the bees are not taken indoors in winter, the multiple-storey hives are sometimes wrapped with black packing paper (pergamine). When spring comes, the hives are "undressed" before their bottoms are replaced.

How to help colonies living in long and 12-frame hives. To provide favourable conditions for proper life and spring growth of colonies living in such hives is much more difficult to accomplish than it is in multiple-storey ones.

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In a long hive, which was inhabited by only one colony in winter, one half of the hive is kept free and clean. It is to this part that the colony is moved. But before this operation, a reserve flight entrance is opened in the free half of the hive. The nest is opened only to its one or two frames, so that robber bees are not attracted to it.

If a colony has wintered poorly, the empty, molded honeycombs and those unserviceable for brood rearing are removed and replaced by good ones. The nest is arranged anew. The honey-richest comb is installed closest to the side wall, next to it is placed the one with honey and beebread, and after that a brown honeycomb with small reserves of honey for queen's egg-laying. Then one puts inside all the frames with brood (it is desirable to arrange them directly opposite to the flight entrance) and the remaining honey-beebread frames in such an order. Then the nest is closed with a ceiling and covered with a warming mat.

The liberated part of the bottom is cleaned from the dead bees and rubbish; the floor and the inner walls of the hive are carefully scraped out and rubbed clean with a wet rag. Close to the insertable board one places a good quilt and covers the hive with a roof. Later on, it will be better to move the colony into a clean hive, safe from any infection.

In early spring, daily fluctuations of the air temperature may be very drastic. In such cases, which may be rather frequent, bees have to spend excess energy to keep their nest temperature normal. Bees require more honey and wear out faster when the air exchange in the hive is more intensive and the heat leaves the nest more rapidly.

To maintain the necessary nest temperature is particularly difficult for weak colonies. And if they have to rear the brood at a temperature which is even half a degree lower than the optimal, the offspring will be much weaker, all its qualities will be inferior, and the proboscis in the young bees will be smaller.

To help the colony preserve the heat in the hive with minimum expenditures of food and energy – this is the purpose of all efforts to warm the bees' nests, to protect them against wind and it is also the reason for diminishing the flight entrances.

If in winter a long hive was inhabited by two colonies (the principal one and one with queen-assistants), there is no spare room in the hive for colonies' displacements which are in such cases settled in reserved and clean hives that have been previously disinfected. The procedure is as follows. The hive with the colonies in it is moved backward and in its stead the beekeeper places a new one with its flight entrances facing in the same direction.

At first, the nest of the main colony is opened. Inspecting the frames upon their withdrawal, the beekeeper decides whether to take

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them into a clean hive or to discard them. The nest is arranged in the usual way. The weather and season permitting, the frames should be adequately cleaned (the wax outgrowths on the side beams should be scraped off, the side and lower planks must be refreshed). The same procedure is followed for the nest of the assistant colony.

The empty hive, its bees having been transferred into a new one, is removed from the apiary; its dead bees and wax rubbish are swept off, it is washed, disinfected and then used to house another colony.

To arrange a 12-frame hive properly is much more difficult. Such hives are scarce in volume, they often lack room in which to transfer the nest. To be able to clean the bottom, one has to remove several honeycombs and put them into a movable box.

The exposed part of the bottom is cleaned of its rubbish and the desired number of frames are installed, which were previously scraped well to remove their wax outgrowths. In the same way one cleans up the entire nest and its bottom. For the time being, it is better to transfer the colony into a clean reserved hive. If the colony has enjoyed good wintering, its nest does not diminish in size.

If there is no brood or the brood is of drone-laying queen it is a sign that something is wrong. When one inspects the nests in spring, he may suddenly see no brood in the colony despite the latter's normal flight. This state of the nest at such a time is a sign that something is wrong in the colony, though it is too early to decide that it is motherless. The fact that the colony has no brood does not yet prove there is no queen. For some reason, the queen might not have started laying eggs yet. This may happen either because, up to the very last day, the colony was in deep dormancy and rest, so that its instinct of reproduction has not yet awakened, or its queen is sick and has lost her ability to lay eggs.

A broodless colony, which by all apparent indications has enjoyed a normal wintering (the nest is clean, the food stores are quite sufficient), should not be disturbed. Its brood is sure to come into being in some four or five days. But if during the second inspection of the nest the beekeeper still does not find any brood there, the queen is replaced by a healthy one. The sick queen is caught and killed. As a rule, such sick queen moves slowly, dragging her abdomen. If the inspection of the nest is not professional and adequate, the queen may get injured and one or two of her segments may be crushed.

A good queen, to improve the condition of the colony, is usually taken from the nucleus or the queen cells (such nuclei are specially left for winter to be employed later for replacing the queen if necessary, or they may be arranged so as to provide reserve-colonies in case of two-

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queen beekeeping). The good queen is let inside the colony after the beekeeper sees it has lost its queen: there is unharmonious noise of alarm, the front wall of the hive and the flight board are covered with bees running to and fro. Bees enter this state 20 to 30 minutes after their queen is removed from the nest, and occasionally later.

It is easier to take the reserve queen from the nucleus together with the honeycomb where she was laying eggs. In such cases the queen and her retinue are covered with a big cap. All other bees are carefully swept off this honeycomb back to their nest. The nucleus (queen cell), now queenless, is attached to the neighbouring one or to the colony on whose right or left it was wintering.

The frame with the queen is placed in the centre of the queenless colony's nest. In twenty four hours the queen is set free. It frequently happens that the queen is released by the bees themselves: they dig a passage in the honeycomb right beneath the cap.

The nest would have no brood if the colony lost its mother (queen) during wintering or not long before the flight of cleanliness. Most often, it is the old and worn-out queens that die. If a queenless colony is very weak, it is liquidated by joining it to another colony. If a colony is still vital enough to grow further independently, it is improved by receiving a nucleus together with the nest. The nucleus (queen cell) is placed at the side of the nest and separated from it by a dummy diaphragm (partition), which is lifted up 7 to 8 mm for the night hours. Through the slot formed near the hive floor, the colonies gradually join together. After one or two days, the partition is withdrawn, the nests are reformed (the brood is concentrated in the middle), and the extra frames are removed.

The miserable state of the colony can be immediately and without any mistake recognized by its brood. If a colony is good and strong, its brood by this time is usually composed of young bees of all ages. At an earlier stage, it is still uncapped. Its transparent, slightly bluish eggs and pearly white larvae can be well seen. The brood of an older age is carefully covered with little caps. The caps are dark-brown (at this time, bees do not secrete any wax yet and, in order to seal the larvae, they take it from the nest), somewhat convex, almost flat; the edges of the cells are brightly outlined. This kind of brood will give rise to worker bees. If the brood is continuous and has no empty or missed cells, it means the queen of the colony is fertile and in good health. If the cells of the comb are covered with convex, dome-like little caps, beneath caps of this kind no bees will develop except for inferior small drones. A brood of this kind results from a drone-laying queen or a laying worker which can develop in a motherless colony. Such a brood is a signal of danger.

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Queens turn into drone-laying ones when, due to bad weather or to a shortage of drone-bees, they failed to mate and enter the winter being a virgin. Their sexual organs lack the sperm which is the male semen. Virgin queens lay unfertilized eggs. In spring, following their instinct of reproduction, these barren queens, like those completely fertile, begin egg-laying. They put their eggs into bee cells, but only male bees grow out of these eggs. Drone larvae are larger than those of bees, the ordinary cells are too small for them, and therefore bees build-on to these cells and seal them with sharply convex caps.



In search of nectar.

Virgin queens which have lived through the winter cannot mate in spring. Colonies with drone-laying queens are doomed to die out. Their bees are old, they were reared last summer and entering the winter were already worn out. Even if they do live until their spring flight, they will inevitably die in the very first days after it. To save such a colony by itself is impossible. It is usually joined with another one which should be rather average in strength. To unite the colonies, a sheet of paper or tobacco smoke may be used. The drone-laying queen is always found and killed.

At the end of the day, after the bees' flight, the hive with the colony to receive the motherless one is put aside; in its stead a new hive is installed and its flight board is attached with special ramps. Then the hive with the motherless colony is brought there. The smoker burns, with a handful of rustic tobacco in it, and its smoke fumigates the bees in both hives. Affected by the tobacco smoke, the bees get drunk on the honey, and the smoke also subdues them.

After a short pause the bees are shaken off from the combs onto the ramps, first from one hive, then from the other. Getting mixed, the bees gradually enter the hive. They are directed to this hive by the same smoke. The nest for such a colony is made of the frames which were used by a normal one; if necessary, it is supplemented by honey frames from the nest of the destroyed colony.

This method of uniting the colonies is quite reliable. It precludes

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any possibility of the bees' returning to their old places. Their reflex to come back to their own home seems to be swept off by the effect of the stupefying smoke and the very process of begging to be accepted into the new hive. Bees behave very much like a bee swarm or solitary bees which have lost their way and are trying to find some shelter in other colonies' nests.

This method is successfully used to unite two or three colonies which become weak during winter (their queens are not removed). Weak colonies are not profitable. As A. Ye. Titov, a famous expert of commercial beekeeping used to say, "Weak colonies, poor in bees, should not be tolerated in the bee garden, even when their queens are still alive. Such colonies fail to get stronger by the time of the main flow; they will only bring you no profit, but most probably, they won't even be able to gather provisions for themselves to last through the winter. Weak colonies demand still more care and cause the beekeeper many problems; frequently they are the reason for all attacks occurring in the apiary."

Good results can be gained if the beekeeper unites the weak colony or the motherless one with its neighbour by using a sheet of newspaper. The nest of the normal colony is covered with the sheet of newspaper in which pinholes or breaches are made with a chisel; the hive storey containing the nest of the colony to be destroyed is placed on this sheet of newspaper. The beekeeper must be very careful to disturb the bees and to use smoke as little as possible. The hive is covered with the roof. The bees in both colonies, getting rid of a body foreign to their nest, gnaw the newspaper through and approach one another closer and closer; then they quite peacefully unite and start working. In a day or two, when the bees have already gotten used to their new home, the nest is rearranged.

None of these first jobs of spring should ever be put off or postponed even for a brief hour. Early spring weather is extremely variable. It frequently happens that on the very next day after the first flight, the air temperature falls sharply, there are frequent winds and rains which for many a day make it impossible to open the nests and assist the bees. Under these conditions bees, whose wintering was not successful and who are now deprived of any help, get into trouble and their situation becomes acute, thereby retarding their growth for a long while.

The reproduction instinct is the guiding force. The only aspiration of the colony at this time is to provide for its future existence. And this desire is easily understood: the colony has just come out of the hardest period of its life, namely, out of wintering. The bees' organism has

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greatly worn out during winter; the harder their wintering was, the more worn out it is. The bees have greatly aged and for many of them their life span has nearly approached its end. That is why every bee colony is doing its level best to raise a new generation as fast as is only possible.

The instinct of reproduction, thanks to which the bees accumulate in such huge masses, becomes the guiding force at this time, ruling all the activity of the colony. All other instincts become its servants.

To get their nectar and pollen, the bees are driven by their instinct for food provision. But at this time they are looking for food not so much for storing it as reserves, but mainly for feeding their offspring. And it is not accidental that the colony tries to put the gathered food as close to the brood as they can, so that it is convenient for feeding the larvae. At this time, the bees are particularly eager to gather pollen. If a colony is deprived of its stores of beebread, the majority of forager bees no longer searches for nectar but looks only for plants bearing pollen. *The growth of the brood and the honey yield are directly related to the amount of beebread in the nest and the supply of pollen.*

In the period of a colony's growth, flower pollen is more vital for the bees than honey. Therefore it is most desirable to locate the apiary amidst wood-and-shrub plants which are richest in pollen. Forests, especially thickets of willows and maples, can abundantly provide bees with this priceless food. Forests are also extremely valuable for their ideal microclimatic conditions greatly supporting the growth of bee colonies. It is always quieter and warmer in the forest; there is usually more moisture, and the vegetation is more diversified and richer. When living in the forest, bees do not have to spend as much energy to gather their food and wear out much more slowly.

Now comes the time when the bees have cleansed their stomachs, and the flightless winter period is already in the past. The bees' instinct for economy, which so recently restricted them in spending their food, seems to be fading now. Now they may enjoy their food without any limitations. Nature has opened to them all doors to its treasures, namely the nectar and pollen. A direct contact between nature and the bees is well established now. With every bit of nectar, brought into the nest and pollen pellets, the bees' food becomes more and more abundant and satisfying.

Gradually, one after another, numerous representatives of the willow family begin to bloom. They are first-class honey-(nectar) and pollen-bearing plants of early spring, the source of the first productive honey yield. Forest lowlands and ravines are still covered with snow, the thawing waters have not yet run off, but on the forest edges and undergrowth, on the banks of ponds and rivers, one can already see

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golden inflorescences of sharp-leaved willows, purple osiers, goat willows and powerful white willows. It is almost for a whole month that the bees can carry their nectar and pollen, frequently two or three kilograms per day, and occasionally even more. The flower pollen of the willow is very rich in protein and is extremely nutritional.

The willow family is joined by that of the maples: the Norway maple, Tartar maple and sycamore are all very valuable as nectar plants and as sources of pollen.

During good springs, strong colonies can gather a whole brood chamber of salubrious and wonderful honey, as well as increase their reserves of beebread considerably. Bees' nests look fresher and restored; they are expanding with the new brood. The hives are gaining weight. The entire apiary is fragrant with the smell of fresh honey.

Hundreds of bees gather water. They take it not only from drinking bowls but also from the sun-warmed brooks, wellsprings, ponds. Bees seem to be badly looking for mineral salts, because they take water from all kind of grass, especially after warm spring rains. At this time, the colony needs water to dissolve the honey crystals (with the low winter temperatures, the unsealed honey in the honeycombs became crystallized), to prepare food for their larvae, and finally, to provide a certain microclimate in the nest, which is necessary for the normal development of the growing organisms.

The reproduction instinct governs the behaviour of bees which are already engaged in some jobs inside the hive. It is true not only of nurse bees, but also of those preparing honeycombs for laying eggs in, or processing the cocoons left after the birth of young bees, or polishing the cells. Each and every minute they are all near their queen, feeding her with their jelly, which promotes intensive formation and progress of her eggs; they take the best possible care of their queen.

The fact that the reproduction instinct prevails over all others is manifested in the following. The queen lays eggs only in bee cells (those of drones will be left untouched, even if they are in the very middle of the nest); the colony builds its honeycombs only of bee cells, too.

In this way, during early spring the colony takes special care to raise females, i. e. such offspring of theirs which will be able not only to replace the wintered bees, but also to rear new, still stronger and more numerous generations.

At this time, two processes, which are diametrically opposed to each other but still closely interrelated, occur in the colony. One of them is related to the natural ageing of bees and their wearing out caused by hard work; the other is their struggle for existence. Every

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day shortens the life of bees which have survived the winter, and the hour of the death approaches. Simultaneously, the colony's offspring is gaining force and power to make the colony younger. Both processes are ever accelerating. The whole future of the colony depends on the pattern these processes acquire: the colony may develop well and fast, gain force and reach its biological maturity by the onset of blossoming in the main honey plants, or within a short time it can grow very weak and will never be able to exist independently.

The longer the bees live after wintering, the more the colony preserves its might and force, the faster the queen lays her eggs, the greater the number of their well-fed larvae and the larger is their brood; likewise the colony proves to be less affected by the perishing of its old bees.

If a colony entered the winter being strong and consisting chiefly of young autumn bees, and if during winter they have not worn out physiologically, then within three to four weeks after their flight of cleanliness the bulk of the colony remains almost unchanged, and even somewhat increases. The colony maintains such a stable state even when great numbers of badly wintered bees begin to perish, i. e. a month after the first flight. This can be explained by the fact that the number of bees perishing in one day is replenished, and often even overcompensated for, by that of newly born bees. A strong colony does not weaken during early spring, but manages to maintain its might and power. Therefore it is capable not only of rearing large broods but also of sparing essential reserves of bees to collect nectar and pollen.

Their flight always remains very intensive. One has an impression that the colony is using all of its reserves. Particularly mighty is this flight when the willow and maple trees are just beginning to bloom. Under natural conditions which favour nectar secretion, some colonies may gather from these trees as much as 16 kg of new honey, and even more.

Later, the intensity of the bees' flight for nectar and pollen may diminish somewhat, even though nature continues to provide them in greater quantities. It may happen when the queen begins laying 2 to 3 thousand eggs per day and all wintered bees are replaced by young ones. Then the brood-rearing jobs in the nest require more of the bees' time and efforts. It is fantastic, but each and every larva is visited by nurse bees 1300 times daily, and during the entire stage of larval growth they pay about 10 000 visits!

If a colony has had a bad winter and is now weaker, the life span of its members is much shorter in spring. In the first few days after their flight, these bees are also active in gathering food, the queen is in a hurry to lay eggs, but that energy is soon to expire. Exhausted during

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their hard winter, they get tired very quickly. One can see that the flight of such bees is losing force already in the second half of the day.

If a colony is weak, its nurse bees attend to the brood with overstrained efforts. At first, the growth rate of the brood number grows. Then, even before young bees start accumulating, it does not change for a while, but then it drops sharply. The number of old bees perishing now is several times greater than that of young ones growing up. It is more and more difficult for the colony to provide proper conditions for the growth of its offspring (to expand the zone for the brood, to maintain the heat in the nest, to feed the larvae efficiently, and to do other jobs). The queen, even being young and fertile, does not increase her egg-laying, but reduces it. The growth of the colony, which is now in a very critical situation, is coming to a stop. If the colony is not helped out at this moment, in other words, if it is not fortified at the expense of other colonies, then, no matter how fine the weather conditions for honey harvesting may be, this colony will never be economically profitable, it will never produce commercial honey, but at best will only be able to provide food for itself. However, it is not desirable to remove the brood or individual strong bees from good colonies in early spring. Such removal can inhibit their growth. Therefore it is more practical to unite several weak colonies or to join them with strong ones.

In apiaries employing the technique of two-queen beekeeping, it is possible to use a portion of a weak colony for arranging artificial swarms as reserves.

During the first spring weeks, when the natural conditions are not yet good enough for productive honey flows, strong and well-kept colonies with good food provisions do not need any special care. They are left in peace. Whatever they may need for their life and reproduction, they can find in their nests.

As soon as the first spring nectar plants (the willow and maple in the temperate zone, the fruit-bearing species in the south) burst into bloom, the bees' nourishment gets richer. Forager bees, whose contacts with nectar are constant (in the day time they collect it from flowers, in the night time they process it into honey), willing or not, naturally consume it in much greater quantities than when it did not occur in nature and they had to eat their old reserves. Together with the nectar, they swallow pollen grains that have fallen into it.

With the arrival of fresh nectar and pollen, the nurse bees, while preparing food for the brood, also consume more food, particularly that with protein. On the whole, the colony is now getting stronger.

The bees secrete their wax. Abundant nourishment stimulates the activ-

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ity of the bees' secretory glands, including the wax ones. Bees secrete wax involuntarily. However, the intensity of wax secretion does not depend on their nutrition alone, but also on the colony's requirement for this building material.

Wax is secreted on the surface of the so-called wax mirrors situated on the lower segment of the bee's abdomen. It accumulates in the pockets and hardens there as tiny little scales. One can easily see two rows of white or slightly creamish coloured scales on a mason bee or a forager bee. Wax is usually secreted by young bees. Nevertheless, the wax glands may begin functioning even in bees reared the previous year if they did not do any jobs in the nest in autumn and their glands have not worn out physiologically.

The first sign that the secretion of wax has started is the so-called whitewash (embryo of foundation) of the honeycombs as the cells are being elongated. The first place that bees build cells in which to store their fresh honey is in the upper part of frames.

While cleaning their nest, bees frequently destroy the dirty sections of the combs. When the wax secretion begins and it becomes necessary to expand the area for the egg-laying of the queen, bees restore whatever was damaged and complete their building of the comb sections still unfinished. The nest is refreshed and looks as if it were whitewashed.

The wax they secrete is also used by bees for sealing the cells with the brood which are now filled with honey; then it is used for building new combs. When the honey harvest is good, the wax secretion is stronger, the amount of wax so secreted increases with the increasing needs for the repair and expansion of the nest.

The unused wax is stored as reserve; bees leave it on the upper rods, lateral and lower planks of the frames and on the internal side of the ceiling as little dense lumps, outgrowths and nodules. Before their wax glands begin functioning (in late winter) or have already stopped their work (in autumn), when in need of wax, they, as insects with a great sense of economy, take wax from these reserves.

It should be noted, however, that bees lose many wax plates while collecting nectar, and especially when forming the pollen pellets by carefully cleaning the pollen grains off their bodies; they also lose wax plates in the very hive (one can see wax plates on the hive bottom).

To be able to use wax (which is a most precious building material) immediately in their work instead of storing it and losing it, bees can be helped out and compelled to build honeycombs before the colony actually needs to expand its nest. To this end, the nest of a growing colony is artificially torn to pieces, in other words, the honeycombs are isolated from one another at a distance which exceeds the natural

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passageways of bees (little streets). The bees immediately respond to this disturbance of their nest. They gather in huge masses near the places of disruption and begin building them up with combs or narrowing them. The instinct for building honeycombs gets sharper.

Man, knowing about this biological peculiarity of bees, began specially to tear their nests so as to compel the bees to build honeycombs before the colony renews its ranks and its nest becomes too small for its members.

To speed up building processes, to make honeycombs stronger and better, the hives are fitted with frames containing foundations which, in fact, are sheets of wax, equal in size to the clearance in the frame with the limits for bee cells being well marked.

When these frames are installed in the nest between the honeycomb and the foundation sheet, a space not of 12.5 mm but twice as big forms. The bees will not like this artificial breach in their nest and will not adjust to it. They will build up cells on both sides of the foundation, and the integrity of the nest will be restored.

In spring all activities of the colony are governed by the instinct of reproduction: bees construct honeycombs of extra quality, exclusively of bee cells from top to bottom. At this time, the colony exploits the foundation sheet only in small building groups, due to which the sheet does not get elongated and the cells come out to be of absolutely normal shape. The conditions for larval growth in such combs are particularly favourable, and bees reared in them prove to be large and healthy. Spring honeycombs are the best ones. They are surprising in their fancy pattern, tenderness, lightness, and they look as if they were woven by most skillful lace-makers. If it were only possible to build nests of such combs alone, these nests would be ideal. The beekeeper should never miss the spring, which is the most favourable time to renew the nests and to provide for the fund of honeycomb.

Frames with foundation are usually installed in the hive as soon as bees begin whitewashing their combs. But one should be careful not to overexpand the nest in early spring, which is dangerous: it may hinder the growth of the brood, and occasionally, when the temperature is very low, the brood may get supercooled and, if situated at the edge of the nest, on the side opposite to the combs under construction, it may even die. This is the case frequently observed in horizontal hives. Long and 12-frame hives are provided with one frame which is usually inserted between the food and the end combs containing the brood. Strong colonies, occupying nine or more frames at a time, may have two frames between the combs with the open brood of many nurse bees and mason bees together.

When kept in multiple-storey hives, the colonies usually occupy

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two storeys. Their nests do not undergo any changes in terms of size. But, not to prevent the queen's work and to permit the bees to build their combs, the storeys of the hive are reversed in order: the upper one, as soon as it is filled with the brood, is placed on the bottom of the hive; the lower one, where so far no brood could possibly develop, is moved upward. One or two empty honeycombs are removed from the upper storey, and in their stead the bees receive frames with foundations. It is better to install these frames in the middle of the hive. When so arranged, there will appear a vacuum in the upper part of the nest which the bees will not tolerate.

The rearrangement of the hive storeys and the installation of a foundation in the main part of the nest create somewhat unusual conditions for the bees. In their natural home, bees store honey in its top, above the brood. With the hive storeys reversed, it happens to be on the bottom of the nest. The bees cannot adjust to this situation and immediately begin transferring the honey upward, leaving only some small bits of it near the open brood. The additional work, which is required for carrying the food stores here and there, compels them to eat better than the bees that are not engaged in such jobs but are only collecting nectar. As a result, the activity in the colony increases, the queen moves upward to find that these are vacant combs and new ones under construction, and her egg-laying accelerates. Meanwhile, the bees, which remain in the badly fitted part of the nest, have to rebuild the foundation within a short time so as to restore its integrity.

Colonies, which are weaker after winter and now occupy only one storey of the hive, do not have their honeycombs replaced with foundation during this period of early spring when the wax is secreted. Such colonies are loaded with necessary construction jobs while their nests are receiving second storeys.

So, the time and extent of nest expansion due to the installation of foundation frames in all type of hives do not depend on the beginning of wax secretion alone, but also on the strength of the colony, i. e. the number of bees and the size of the brood. If all the frames in the hive are densely occupied and on the frames next to the end ones there is some egg-laying or, moreover, some sealed brood, it will mean that the time for nest expansion has already been missed, and there is no vacant room in the nest for the queen's egg-laying. The rhythm in the nest is disturbed and it will not pass without consequences for the colony.

When colonies are in extremely good condition and their nest boundaries may inhibit the work of foragers (too little room for storing their supplies of fresh honey), if the nests in 12-frame hives were reduced, now they can be restored to their previous size, some of them

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receiving chambers with empty combs. In the same way, one expands the number of nests in long hives, too. In a multiple-storey hive the colony gets a chamber with empty combs for its honey installed above the second storey. Several frames with foundations are also installed.

The working flight entrance (the lower one) is widened to meet the needs of the upcoming flight, and additionally another one, round in shape, is opened in the lower storey to let more fresh air into the brooding part of the nest.

The colonies in such condition are left untouched for about three weeks, in other words, until the time when the nests will again need to expand to accommodate the colonies' growth and the honey storage. The flight entrance in the second storey is kept closed.

The most important thing in this period of early spring is to provide conditions for the colonies' normal growth, irrespective of the weather and natural harvesting of honey.

The Accumulation of the Hive Mass



he bees which have lived through the winter have already accomplished their task. They have brought up new generations, properly fitted and refurnished the nest, filled it with brood, collected stores of fresh honey and beebread. In other words, they have provided every necessary condition for the normal life and further development of the colony. This work had utterly worn out them and they perished.

With the death of its old bees, the colony qualitatively changes. In actuality, there is already quite a new colony in the hive. Its future lies ahead of it. One can say that a colony after wintering is like the sun setting, while a colony born in spring is like the sun on the rise.

A refreshed colony, like any other young organism, is full of energy. Its members are physically strong, powerful, capable of doing many jobs which are many times harder and within much shorter time than bees that have wintered. The endocrine glands in such young bees, particularly the glands responsible for secreting jelly and wax, are now functioning very intensively.

As they enter winter, the bees face a serious task set by nature: they have to survive and create the foundation for a new colony which would then be capable of independent development. The bees bred in spring must prolong the existence of the species by swarming, i. e. by separating their young colonies. Though the qualities of the new colony are much better than those of the old one from which it came, it has not yet gained enough force to accomplish its main mission. To be able to produce new organisms like itself, the new colony must first of all mature and gain in weight. A bee colony, whose life goes on thanks to its powerful instinct of reproduction, in fact, strives as much as it can to achieve this goal.

Bees begin paying more and more attention to their queen, offering her abundant and the best food. The very first instant the queen takes a break from her egg-laying some bees of her escort immediately rush to offer her new food, others tenderly caress her with love and affec-

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tion, and still others thoroughly clean her. With this wonderful concern and excellent feeding, the queen's sexual organs begin functioning ever more effectively, soon reaching their physiological apex. At this time queens usually lay, on the average, two or three eggs per minute. L. Langstroth, an outstanding American beekeeper, encountered queens which could lay as many as six eggs per minute. Such tremendously great egg-laying is only possible if the nest has abundant supplies of honey and beebread. As A. Root wrote, it is hard to imagine what huge amounts of food a colony requires to rear an army of worker bees by the beginning of honey harvesting. In the second half of the colony's growth period, the number of its brood expands with most surprising speed if the bees are well supplied with sufficient quantities of honey and pollen with which to raise their larvae.

The colony growth in spring is directly proportional to the amount of food available. This regularity is valid under any weather conditions, particularly when the food stores in the nest are abundant or, on the contrary, minimal. Out of 90 to 100 kg honey and 34 kg beebread consumed by a colony during one year, almost half is eaten during spring. To raise a frame of brood, bees use a frame of honey, or one full cell per bee. To raise one kilogram of bees, it is necessary to use almost one kilogram of pollen. Nutrition is of decisive importance for the intensity of the bees' growth, and the more honey and beebread they consume, the larger is their brood.

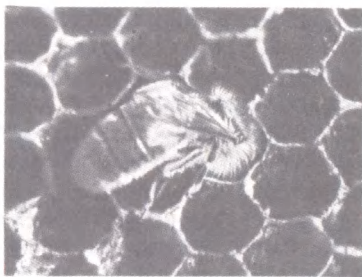
The reproduction instinct becomes dominant and involves the entire colony only when the nest contains at least 15 kg honey in a 12-frame or a long hive or over 20 kg in a multiple-storey one; the quantity of beebread should always be great enough. With such abundant reserves of food, bees can easily feed themselves, their brood and their queen. Furthermore, their instinct to economize food is not aroused in this case. If such nutrition is guaranteed, the colony's growth will not diminish even in bad weather when the bees are not able to fly beyond the hives to collect pollen and nectar. No adverse effects of such negative factors have been observed so far, provided the bees had sufficient quantities of food inside their nest. When their stores of honey became depleted, the bees become more anxious and concerned for the number of their offspring, while with sufficient food reserves such alarm in the nest was not encountered.

Nevertheless, many beekeepers still underestimate the great role played by abundant food reserves. It happens rather often that good colonies are left for wintering with only 16-18 kg honey and with very small quantities of beebread. Later, such stingy beekeepers are surprised when these colonies show low productivity, because upon external examination they seem to have enjoyed their wintering well

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Collecting fresh fodder.



A bee piling her nectar.

enough but their food supplies were increased only in spring.

Beekeepers of experience are quite just in thinking that excess quantities of honey and beebread will never do any harm to bees, as they never waste a single gram. For apiaries in the temperate and northern belts of this country, 20-25 kg honey provided to bees in the hive in spring is not at all excessive. Such quantities of honey are not difficult to place inside multiple-storey hives, and at the same time they save larger areas of combs to be filled with brood. In 12-frame hives, large reserves of honey will considerably diminish the area for brood and will hinder queens in their work. In view of this, it is much better to keep the main reserves of food in 12-frame hives above the bees' nests in special supers.

In hives with honey reserves depleted to critical levels (8-10 kg) and the weather conditions not permitting any collection of nectar, the colony's instinct for food economy will intensify. Then it will be this instinct and not that of reproduction which will govern the colony's activity. The bees will minimize the amount of honey used for nourishment, their endocrine glands will reduce normal functioning. The brood feeding will also deteriorate, resulting in a generation of lower vitality, and rather frequently of poor development and growth.

If at this very time the beekeeper fails to replenish the food supplies (most of all, those of honey and beebread), the queen will sharply decrease her egg-laying activity and when the food comes to an end, she will stop completely. The bees will begin throwing out first the open, and then the capped brood. Now the colony is driven not so much by the instinct of food economy but rather by that of self-preservation. It has been noticed that if a queen's egg-laying has been interrupted for at least three or four days, she is very reluctant to renew it again.

Large and constant reserves of food in the nest are necessary. Only under such conditions may the colony enjoy its normal life and activity. However, the instinct of reproduction will become still stronger, and

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the egg-laying will grow and reach its maximum, if the bees are provided with the conditions typical for honey flow.

The arrival of fresh nectar and its processing strongly excite the colony and heighten its vitality. Now the bees are doing a great variety of jobs inside the hive, they improve their tending of the brood and the queen. All this promotes the speedy growth of the colony. It is vitally important to see to the continuous supply of pollen and nectar throughout the entire period of the colony's growth. If nectar plants in the area of the apiary are scarce, the honey flow will be poor and interrupted, occasionally for rather long periods. Under such circumstances it is better to move the bees to some other locality where the land is richer in nectar plants. When it is not possible to transfer the hive far enough, one can excite via feeding with honey or liquid sugar syrup. The bees will experience the illusion of honey flow.

Bees try to expand the boundaries of the brooding part of their nest so that the queen has the space necessary for laying eggs. Some groups of bees build up combs on the foundation, others prepare new areas of cells for the brood on vacant combs by cleaning and polishing the latter. There are other groups of bees which do the same kind of labour inside the nest where the brood rearing is still more intense. As soon as a young little bee emerges from her cell, a cleaner bee will appear immediately near the cell who will begin cleaning it with ardour. Then the queen will again lay eggs in the newly prepared cells.

Meanwhile, nature is enjoying the ever stabilizing warmth in the air, and new and more numerous species of nectar plants are bursting into blossom. Pollen and nectar harvesting increases. Every day greater numbers of young bees appear in the colony; they were fed by last year's bees. It is true that the new colony, with all its improved qualities, will also lose some of its members because of wind, rain, foes and diseases. But as compared with the period of early spring, the losses will be many times smaller. The colony grows, as it gains in live mass and in volume. The area occupied by the brood also expands.

It is more and more frequent with every new day that young bees leave the nest for their flight. At first, they feel timid and frightened at seeing the sun and the earth for the first time in their life, as well as the emerald green of plants and flowers. Then they get braver, and in joy and happiness fly to and fro, noisily and loudly, inspecting the locality to commit it to memory.

Yes, now the colonies are growing indeed.

"One's aim in working with a bee colony," wrote Professor C. Farrar, "is to create and maintain its might, *without any restrictions whatsoever* (underlined by the authors) in terms of brood-rearing and honey-accumulating."

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The queen lays eggs in bee cells. One of the characteristic biological features of the growing colony is its great concern for rearing only worker bees. The colony needs them to perform the current jobs in the hive and field, later they will be required to raise the next generations which will form the colony's fruit—the swarm, and also to store food for winter. That is why during the period when the colony accumulates its live weight, it continues to build the combs of bee cells where the queen will lay eggs exclusively, completely neglecting sections with drone cells. Neither do bees prepare drone cells for rearing the brood. For the time being, the colony is not in need of drones.

A whole complex of beneficial factors is required by the colony to encourage and not hinder its natural, genetically inherited, exceptional capacity for growth.

It has been found that the queen can work normally, i. e. she can daily lay that number of eggs which her sexual organs secrete, if the colony after its spring flight weighs at least 2.5 kg, and if by the day its wintered (overwintered) bees are replaced, this weight has not decreased but increased. Then, from the very first days of the colony's active growth, it will be able to cope well with providing the heat required in the nest, with tending to the brood, and will also be able to spare essential reserves of bees for gathering nectar and pollen. The offspring reared by such a colony is usually strong and hardy. As the colony is being rejuvenated, the possibilities for its further growth increase. *Only a strong colony can grow normally.*

The rate of the colony's growth depends not only on its own strength, but also on the quality of its queen and on the queen's fecundity. A strong colony can rear large broods and gain significantly in weight only if its queen, during the period of the colony's highest growth, lays as many as 2.5 to 3 thousand eggs per day. Queens may become thus productive when they are no older than two years and if they are specially raised under particularly favourable conditions.

The colony may be extremely good in spring and the queen may lay very many eggs, but the colony's growth is retarded if the nest suddenly proves to be small. To provide conditions for the queen's successful work, the nest again undergoes expansion. *It is only with considerable supplies of food and spare room in the brooding nest that the entire production capacity of the bee colony can be maximally realized.*

In a multiple-storey hive, the queen mainly works in the super in spring. To be able to see if there is any vacant room in it for the queen to lay eggs, one disassembles the storeys from the rear by using a chisel, then lifts the upper storey up and supports it for a while with the chisel or a stick made for the purpose, and drives the bees out by smoke. If the majority of the cells so revealed have the brood in them,

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the storeys will be reversed again, so that the upper one will be on the bottom of the hive and the lower one will be on its top. By this time, the combs in the hive will have been emptied of brood and the queen will receive a big area for laying her eggs. This operation gives the queen an opportunity to work normally for at least two weeks without interruption. Furthermore, just like after the first reversion of the hive storeys, it will strongly revive the whole colony.

The egg-laying will be markedly diminished if the hive storeys are not reversed in their proper order. Having filled the combs of the upper storey with brood, the queen does not feel like going into the lower one immediately. A. I. Root, the founder of the progressive technology of multiple-storey beekeeping, noticed many times that the queen often abandons the lower storey of the hive completely if she can find room for her work upstairs. The queen will be happier to lay eggs in the upper part of the nest which always has more food and heat, rather than in the lower one, usually chilled by the ambient temperature.

The queen stubbornly keeps to the upper storey, trying to discover cells already free of brood. To find such cells takes the queen plenty of time and energy. But having found the cells she was looking for, the queen is able to lay there only as many eggs as she was laying three weeks ago (the maturation cycle of the bee lasts 21 days) when the colony was much weaker and the queen was working half as hard as she is now.

The bees' nest in a multiple-storey hive, left unreversed during the colony's growth, does not stimulate the queen in her work but, on the contrary, retards her activity, reducing it back to the time when the rate of egg-laying was just gaining speed.

Certainly, the queen would sooner or later go down to the lower storey, and begin to work there, but not for long (till she has an opportunity to work in the upper storey again). And, working in the lower storey of the hive, the queen will lay considerably fewer eggs than she did while labouring upstairs. The explanation is simple: while the queen was upstairs, the bees were busily filling with bee-bread the combs of the lower storey where it is still stored. The usable area for the brood is now limited. Therefore the colony will be unable to rear large reserves, and its swarming instinct may prematurely become very acute.

An outstanding American scientist C. Farrar notes that it is a mistake to leave the lower storey of the hive for the brood and not to disturb the integrity of the nest. To be able to use the whole production capacity of a bee colony, as he believes, it is necessary from time to time to change the order of storeys containing the brood, and that

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should be done before the onset of the first main honey harvest. He, for one, used to reverse regularly the order of his hive storeys every seven to 10 days.

Keeping bees without changing the order of the hive storeys turns the multiple-storey hive into a nonseparable stump. Under such conditions, the role of the beekeeper, whose art is in governing the growth and activity of his bee colonies, is now only blindly following their natural development and growth.

When the garden crops burst into blossom, the nests again expand. This will occur some 40 to 45 days after the removal of the hive. Now the numbers of young bees increase with every new day. The colony grows and gets stronger. The previously good nest may become too small for it now, preventing the queen from egg-laying and the foragers from gathering nectar and pollen.

Now the weather is getting warmer than in the days when the willow trees were blossoming. Bee colonies have become younger and bigger. Their nests have expanded, containing many more frames and, primarily, a much larger foundation.

In spring, and rather often in summer, chemicals are employed by forestries and plant-control stations to combat the weeds and pests in fields and woods. These organizations must timely warn the beekeepers about the days of their operations. Unfortunately, this rule is not always respected, and, as a result, many bees are poisoned and perish. It happens occasionally that colonies completely lose their foragers, sometimes they bring in poisoned nectar and pollen which frequently poison the hive bees and even the brood. To protect his bees from such hazards the beekeeper must carefully note all information about the schedule of chemical-control operations which is usually broadcasted over the radio and published in the local press.

A day or two days before the announced time of the operations, he must take his bees out into a safe zone or may leave them in their own nests, if the latter are provided with special nets and covered loosely with roofs and the flight entrances are equipped with special ventilation inserts. On such occasions, the bees should receive a lot of water to drink. It is very important at this time that the isolated colonies enjoy spacious and good nests.

Before gardens burst into blossom, bees begin to show concern for the drones. Now the colonies enter a qualitatively new physiological state which is induced by the swarming instinct.

The growth of colonies is retarded by diseases. Sometimes, a colony's growth stops suddenly not because of the swarming instinct but for some other reasons. If the hive has sufficient reserves of honey and

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beebread, the queen is fertile and young, but the colony does not develop well, one may look for some disease to account for this. The colony may be infected with an American foul or European foul which are infectious diseases of the brood. The European foul usually affects the open brood, the American pest affects the sealed one.

To see which of the foulds has stricken the colony, the nest must be disassembled and the combs with the brood inside must be inspected. The following picture may be found there: the brood is composed of bees of different ages, some cells are releasing young bees; almost next to these cells there are others with brood, yet unsealed and the larvae of various ages, lying in all kinds of positions, some of them like corkscrews, others stretching along the cells, a third group of them with their backs upward or downward; the colour of the larvae is pale yellowish; a few of them have lost their elasticity and look swollen; on the very same comb there are larvae just out of the eggs, the latter lying empty nearby, likewise some empty cells. Such a diversity in the brood's age combined with the emptiness of cells is a reliable sign that the colony is infected with the European foul. The combs with sealed brood will also reveal many empty cells.

When stricken with the European foul, the brood will not die completely. The bees will systematically throw out of their nest the larvae which have already perished and begin decomposing. The queen will lay eggs in the places they used to occupy. That is the reason for such a great age diversity among the brood of the very same comb and the combs being full of holes. If the disease is not caught at once but neglected, both the sealed and unsealed brood will perish. The caps above the perished larvae are noticeably darker than above those developing normally. They also differ in shape: they are not smooth and slightly convex, but, on the contrary, concave and bent in. If such a cell is uncovered, it will reveal a larva already decomposed. Its colour will be dark brown and it will smell of rotten meat.

A healthy brood looks quite different. As a rule, it is almost of the same age on each and every comb. Only in the middle of the comb, wherefrom the queen usually begins egg-laying, are the larvae some hours older than those at its edges. Their position in the cells is always the same, i. e. they are lying on their side; their colour is bright pearly and lustrous.

Bees begin sealing their healthy brood from the middle of the comb, where there are never any empty cells. Such a solid and concentrated brood is a reliable sign to show that the colony is all right.

The picture in the comb with a brood stricken by the American foul differs from that observed in the case of the European foul. The open

The Accumulation of the Hive Mass

brood in its appearance looks completely healthy. This disease progresses and kills the larvae after the bees seal the brood. With time the dead larvae start decomposing, the caps above them get darker and then perforated (the larva attached to the cap with its mouth, drying up and twisting, tears out some part of the cap).

The perished larva is dark brownish, its mass is sticky and smells like carpenter glue. It sticks so closely and firmly to the cell walls that bees cannot remove it.

Colonies affected by the foul, particularly the American foul, cannot cure themselves without outside help. Their growth slows down and ceases completely. If not helped immediately, they may all perish. To be sure the diagnosis of the disease is correct, some small bits are cut off from the infected combs, packed and sent to the veterinary bacteriological laboratory for examination.

Foul-affected bees are treated with antibiotics or sulphamide preparations. Antibiotics are provided per one liter of syrup in the following way: streptomycin (500 thou units), oxytetracycline (400 thou), biomicin (500 thou), methycycline (350 thou), erythromycin (400 thou), and others; among sulphamides, as a rule, the following ones are employed: sodium norsulphazole, sulphanthrol or sodium sulcimide, diluted as 1-2 g per one liter of syrup, depending on the degree of infection.

Antibiotics are first dissolved in cold or slightly warm water which is poured in flasks with the preparations. Then they are mixed with sugar syrup cooled to the temperature of fresh milk. It does no harm to dissolve sulphamides in hot water, too. The syrup is made preferably in the evening hours, and for all of the sick colonies at once.

The healing syrup is administered to the sick bees before night, 100-150 g of syrup per one street of bees; the procedure is repeated three times with intervals of five to seven days. The best results can be obtained if the colonies are treated not with the same drug all the time, but with two or three different preparations, say, antibiotics alternated with sulphamides, or some antibiotics in turn with other ones.

The nests of foul-affected colonies contain extremely great numbers of disease agents. The latter are particularly numerous inside the combs. Some of them penetrate into the honey, beebread, cling to the walls, ceiling, and floor of the hive. Therefore it is highly recommended, for sanitary and hygiene reasons, to remove the infectious nucleus from the nest badly stricken by the foul, i. e. to rid the nest from the combs containing the sick brood; as much as possible, to replace the frames with food by some fresh ones, or to heavily strew them with sugar powder mixed with the healing drugs; the very hive,

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its removable boards and warming mats should all be substituted by clean ones free from the disease agents. Only after all these operations are accomplished, can one treat the bees with the prepared healing syrup.

Before their treatment colonies affected by the American foul are driven into new or well-disinfected hives onto frames with foundations. The nest of the sick colony is completely destroyed: the honey is cut out and used for food or drinks to be enjoyed by man (it is of no harm to people); the combs with the brood, beebread or the empty ones are melted for wax. The mass is boiled within 2½ hours.

The colonies are driven into new nests in the following way. By the end of the day, when the bees cease flying, the hive is set aside and a new one is installed in its place. The new hive is supported by ramps covered with a sheet of newspaper. Onto this sheet the bees are carefully swept off or shaken off, so that not a single drop of honey falls on the ground. The sick queen is caught and killed, the colony receives a new one (the old queen must never be left in the nest because when moving her bowels she will constantly reinfect the nest).

One or two days later, when the colony will have partially built its nest, one can begin to treat it. If the colony is badly infected with the American foul and has been badly weakened, any treatment is useless, and it is more feasible to destroy it.

Before one starts working in the next hive, the tools, the equipment, the clothes, and everything else which came in contact with the sick colony must be disinfected. The beekeeper must thoroughly wash his hands with soap (best of all, with green soap). The ground beneath the hive is thickly washed with bleaching powder and carefully redug. In the USA, as in other countries, in order to prevent any further spread of the disease, all colonies stricken with the American foul are usually destroyed, and those which were in danger of catching the disease are subject to prophylactic inspection and special treatment.

When infected with varroatosis, colonies become nervous and excited in winter. They tolerate their wintering worse than healthy bees, and in spring their growth is found to be considerably retarded. Many of their bee and drone pupae perish. Dead bodies of pupae and underdeveloped bees can be seen on the flight board and in front of it, just on the ground. On the grass near the hive there are plenty of bees trying to fly up, but in vain. Colonies heavily stricken with varroatosis grow very slowly, despite their intensive brood rearing; the swarming instinct does not govern them at all, they almost do not raise drones, and become completely non-profitable. They enter the next winter badly weakened, lose a great many bees, and very often fail to survive until the spring flight.

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The white clover is one of the most important honey plants of the meadows.



Drones infected with the varroa mite.

Varroatosis-infected colonies can be treated with phenothiazine, thymol, formic and oxalic acids.

Phenothiazine is administered in spring and autumn at an ambient air temperature of at least 15 °C. 1.5 g of the powdered preparation is poured in the smoker onto the burning coals, the smoke is directed from the top onto the bee streets and additionally into the flight entrance. The procedure is repeated daily for three days. During a month, the course of treatment is repeated three times, every seven to eight days.

Thermal phenothiazine tablets are ignited and introduced into the hive through the flight entrance with the help of a metal plate. For 40 minutes the flight entrance is kept firmly closed. A dose for one treatment is one tablet of 1.5 g. The whole course of treatment includes three tablets every seven to eight days. The beekeeper must be very cautious to protect himself well when working with phenothiazine: he must wear an antidust or antigas respirator.

Certain methods of the so-called "soft effect" which are of no harm either to bees or honey are also widely used. Among them are various fragrant grasses (herbs) such as wild rosemary, thyme, tansy, coriander, etc.) and all kind of volatile substances with strong odours; the most effective of the latter are thymol, formic and oxalic acids, dill oil.

Thymol is a preparation of plant origin. It is nontoxic to bees. The colonies are treated with it twice—in spring and in autumn. 10 g of the preparation are poured into gauze sacks which are one by one installed in the hive above the nest, under the ceiling or in the space between the brooding storeys.

Thymol vapours kill mites for about two months. The sacks are withdrawn from the hives one month before the main honey flow begins. The sacks are placed in the hive for the second time right after

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the main honey flow, as soon as honey chambers are removed, and they are taken out of the nests when the preparation is no longer effective.

0.2 g of thymol per bee street can be sprayed onto the frame rods three times every four to five days.

Formic acid is used in the following way. A piece of comb packing cardboard about 200×300 mm in size is placed inside an ordinary polyethylene bag into which 150 or 200 ml of concentrated formic acid is poured. When the acid is completely absorbed, the bag is firmly rolled up or soldered. On one of its side along the edges there are two holes, each 1 to 1.5 cm in diameter; then the bag is put on the nest with the holes downward. Before that two little planks are placed across the frames so that vapours can diffuse evenly throughout the nest.

It is also possible to use polyethylene 200 ml flat flasks. The acid is poured into a flask, then a wick is installed, and the flasks with the wicks inside are hung at the side of the nest, or put inside the upper storey. The acid is supplied via the wick and evaporates.

It is very important to use not more than 10 ml of acid. Larger doses may prove to be dangerous for the bees, the brood and the queens.

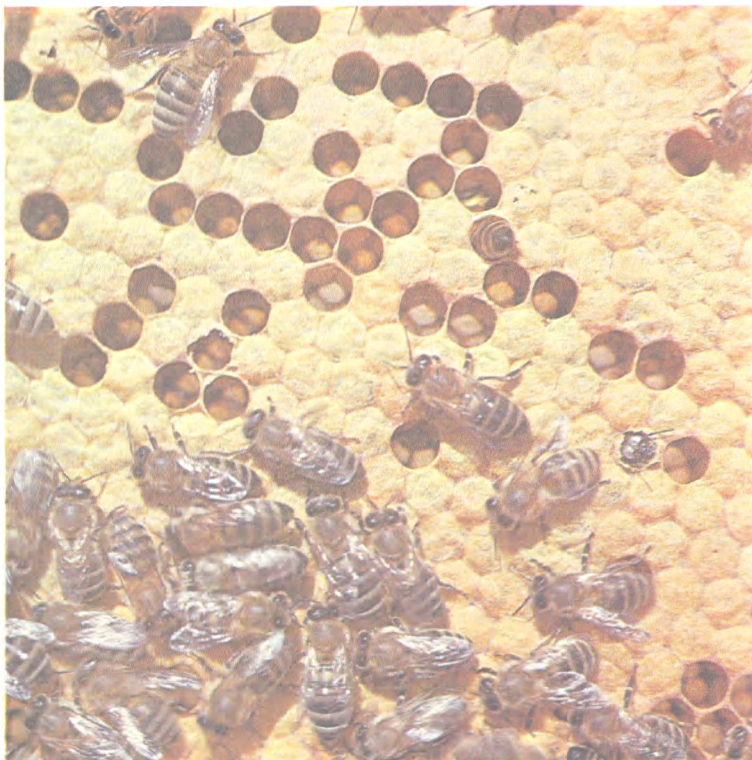
With a high ambient air temperature, the evaporation of formic acid may be very intensive. To preclude it, bees are treated with formic acid for three weeks during spring, and for 10 to 12 days during autumn, when the brood is not large. The preparation may be introduced to the hive for only three days, and the treatment repeated in a week. The whole course of treatment is repeated three times in spring, and three times in autumn.

Oxalic acid is dissolved in water (20 g per one liter) and sprayed on the bees right on the combs. One liter of such water solution is adequate to treat 15 to 20 colonies. The treatment is conducted two or three times during spring and autumn every eight to 10 days.

Good results can be obtained with thermal treatment of sick bees. The bees are isolated from the nest (blown off or shaken down) into a metal mesh case with cells of 2.5×2.5 (3×3) mm in size. The case is placed inside a special chamber, in which the air temperature has previously been raised to the desired level (46 to 48 °C). The air is heated by a thermal electric heater located at the chamber bottom.

The mites which were on the bees die out after the latter spend 12 to 15 minutes in the chamber. The mites fall off the bees and down into a collector situated somewhat above the heater. Large apiaries can employ big chambers where several colonies can be treated simultaneously.

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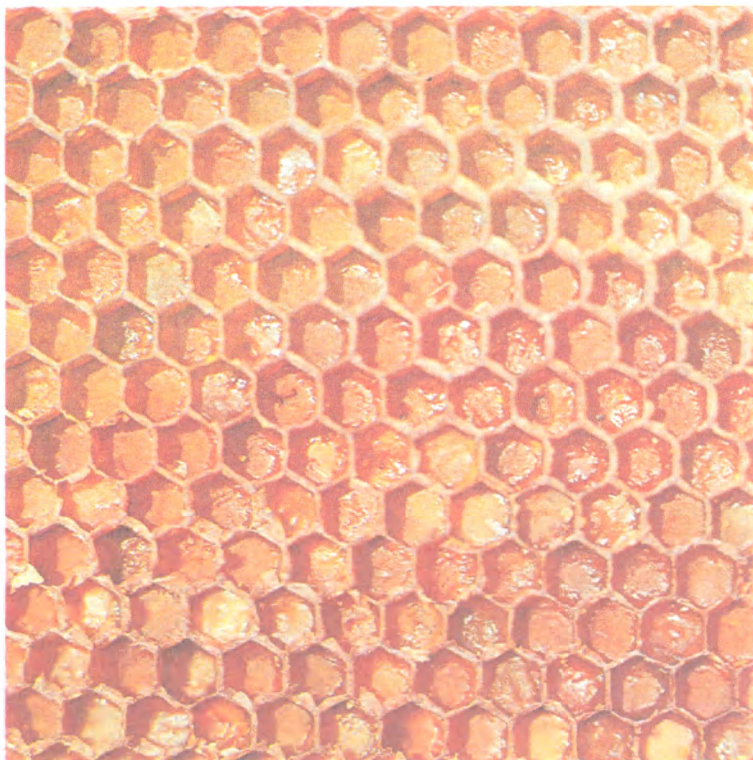


Mature bee brood.

The bees liberated from the mites are returned to their nests. In the case of a 12-frame or long hives, the bees from the case are shaken off onto the nest which is covered with an empty magazine. In the case of a two-storey hive, the treated bees are first shaken off into an empty bottomed storey which is then put under the nest. The bees will very soon rush up into the nest and gather in a cluster in any place they like. The storey freed of bees is removed. If the bees are shaken off right onto the nest, they may form the cluster in the upper storey, and thus will find themselves in an unnatural position with no space between the storeys and no place to lie down.

The treatment proves to be most effective in early spring when the brood is not yet large, or in autumn when there is no brood at all. Queens are not looked for. One thermal treatment is quite sufficient to guarantee the normal development of the colony.

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Beebread—the bread of bees.

Sometimes bees infected with mites can shake them off while cleaning their bodies. The numbers of shaken mites obviously increase when the colony gets excited by honey flow, by artificial feeding, or nest inspection. To preclude any possibility of mites' returning to the nest and onto the bees, the hive bottom is now equipped with a framed metal or capron net with cells of 3×3 mm in size. Through these cells the mites fall down onto the bottom, and any contacts between them and the bees are thus impossible. The infestation may be considerably reduced. Since female mites are eager to lay their eggs on drone brood, the latter is periodically withdrawn from the nest. In advance, the nests are carefully examined so that there are combs free of drone cells. But to help the bees in building drone combs, two construction frames or one-two magazine frames are installed in the nest. After 12 to 14 days the combs with the drone brood are removed.

The Accumulation of the Hive Mass



A comb with fresh honey.

Drone-cell combs may be used many times. Therefore the beekeeper does not break them out, but carefully cuts off the caps from the brood, wets the pupae and the mites with cold water and then shakes them onto a mat and destroys them. The empty combs are returned to the colonies. The number of mites reduces considerably. This technique is very effective in combination with drug treatment.

Bulgarian beekeepers employ varroasine to combat varroasis. They put one to three tablets of this preparation (depending on the strength of the colony under treatment) on a metal plate, ignite it and introduce it into the hive through the flight entrance. Then the latter is closed with a piece of wet cloth. Half an hour later the cloth is removed and in five to eight minutes the plate is withdrawn. The treatment is practiced in spring two or three times in succession every 3 to 4 days, and in autumn three or four times every 7 to 8 days.

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In Rumania, beekeepers employ sineacar, a white powder which has a strong acaricidal (antimitic) effect. Depending on the mass of the bees to be treated, they take from 80 to 150 g of this powder and sprinkle it around the nest. The preparation gets on the frame rods wherefrom it is swept into the bee streets. Then the hive is closed, the flight entrance is used to let in some smoke to excite the bees and promote the parasites' contacts with the preparation.

Sick colonies are treated with this preparation twice: in spring, every seven days, and in autumn, after the nest is freed of the brood.

Beekeepers in the Federal Republic of Germany use a very effective preparation K-79 (chlorodimeform) which affects the mites through the bees' haemolymph.

So, in order for a bee colony to reach all of its potentials endowed to it by nature, such as that for growing, and be able to prepare the utmost possible reserves for utilising the main honey flow, the colony after wintering must be strong, and healthy; its nest must be of such quality and size that it would be not for a tiny instant preventing the work of the bees and the queen which could easily enjoy its sufficient stores of honey and beebread. Food shortage would inevitably make the colony utterly dependent on nature. And if nature does not happen to be generous, the colony may fail to accumulate sufficiently many bees to take the main honey flow.

The Instinct of Swarming Is Awakened in the Colony (the Reproduction of the Species)



Swarming is the birth of a new colony, it is the most solemn moment in the bees' life. It was just this very morning that the hive was quiet and calm, only a few and solitary bees were flying in and out, even though the work on the apiary was already in full swing. But as the sun rises higher, the dew has evaporated, the sky has attained its brightest blue, and a quiet warm day is in full swing. At this moment something happens to the hive which seemed to have been dozing before. In practically no time it suddenly becomes loud and buzzing; excited bees, animated for some reason, begin pouring out of the flight entrance, and thousands of others, like the lava of a boiling volcano, follow the leaders as if driven by a magic force. The bees are accompanied by the queen. Running hurriedly ahead of one another, they try to speed up into the air to join their agitated sisters who are moving to and fro.

The bees' buzzing, solemn and joyful, rises higher and higher into the blue skies, above the apiary, gaining in strength and might.

Dozens of thousands of bees, like a huge and well-tuned choir, are singing to praise and glorify the birth of a new colony. Happily circling around and above their hive in the noisy air, the bees now ascend high up as if trying to reach the cloudless and boundless space, and then, in an instant, they again descend, accumulating into a thick large cloud. In another brief second, like a big fast wave, they are all rolling aside. But the solemn and grand festival does not last long. The bees find a convenient place to their liking, either in some tree crown, or on a bush, and there they begin interweaving into a cluster. The queen immediately notices them and joins her bees. The cluster expands right before our eyes, and then, all of a sudden, the heavy and warm mass is found hanging quite calmly on a branch. This is a new colony – a swarm.

It is believed that bees get together in such a compact mass in order to attract the queen, and then, once convinced of her presence, they

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may calm down and rest, so that, in their own bee language, they may discuss which direction to take in flying to their new dwelling place. As a rule, by the time of swarming the scout bees have already found this new home.

Sitting together in this manner for some 15 to 20 minutes, the swarm takes off into the air, scatters about and makes a circle above its old nest as if to say good-bye. After this it sets out on the path indicated by their scouts. Soon the bees will forget the location of their old home forever, as well as everything else that has remained there. If this swarm is taken and settled in a new hive in the very same apiary, and even next to their old home, not even a single bee would return to her old nest. During swarming, bees lose their instinct for their old dwelling place.

The swarm, having settled on a branch, may remain there for quite a long time, if the scouts have failed to find a proper home for the future new colony before the time of swarming. In this case, the scouts are sent on their mission by the waiting swarm. Some of the bees (those designated as scouts) separate from the main swarm, memorizing the place where the swarm is sitting. Then they fly in different directions: to the forest, to solitary trees, and if the territory is mountainous, to individual rocks. Upon their return, they inform the colony of their findings, and the colony as a whole decides which of the scouts to follow. The swarm usually obeys those scouts whose dance on its surface is most energetic and persistent. The decision made, the swarm readily and quickly takes off and starts towards its newly discovered home.

The swarm does not remain in the same place for long, even if the scout bees return with no news; i. e. if they fail to find an appropriate new nest within some two or three kilometers. The swarm flies to another place where it will hang for a while to inspect the new surroundings. And the search goes on and on, until the swarm finds a good place to settle down. Occasionally it may happen that having lost any hope of finding a good nest, or having exhausted the food reserves they took with them, the bees begin constructing their combs right there on the branch to which they last hang. Sometimes the swarm, if it was not able to leave the apiary in time (because of some adverse change in the weather, or having flown from the apiary later than necessary, in the second half of the day), remains for the night in the place of its settling. In the morning, as soon as the sun warms it up, the swarm takes off and flies away.

But is it only the search for a new home that drives this young colony to unknown, far-away places? No, it is not only that. Practice has shown that the swarm which has taken off, as a rule, would not

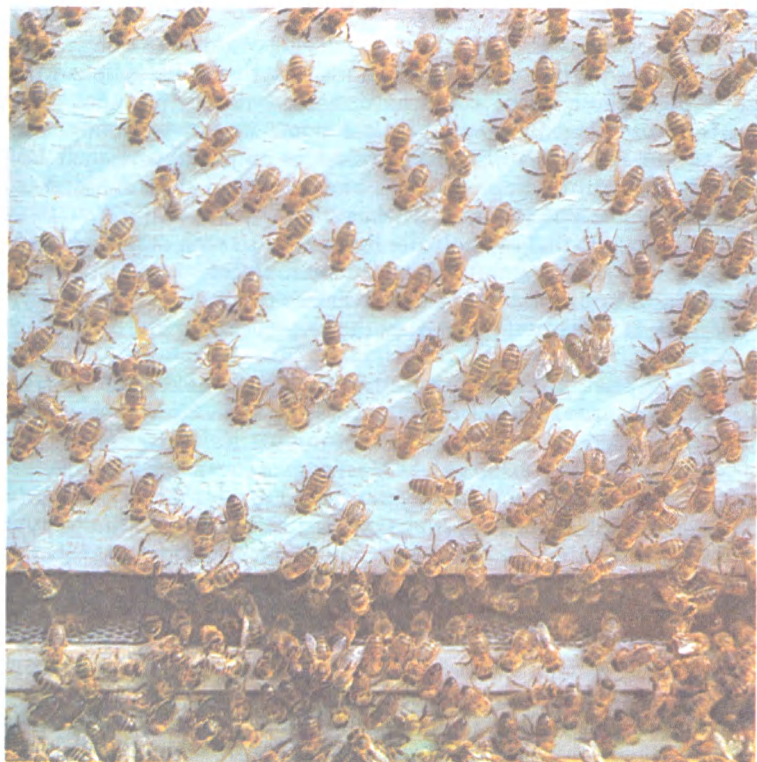
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A swarm cluster.



A pear-shaped swarm.



On a hot day.

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remain in its old apiary even if there is an empty hive. Very often the swarm passes by hollow trees, but if these trees are close to their old nest, though the hollows would make appropriate dwellings, the bees never stop there. And it is frequently the case that such hollows will be inhabited by bees flying from other, more distant apiaries.

The aspiration of the swarm to fly as far as possible away from their native roof reveals nature's great wisdom, because thus the species of honeybees can be preserved from degeneration.

Distant settling of swarms precludes so-called inbreeding, i.e. mating between close relatives, when young queens annually mates with their drone-brothers. Generations from closely related parents are known to be of lower vitality and weakened working capacity. Such generations have practically no resistances to external negative factors and various infections. Prolonged inbreeding inevitably leads the offspring to complete sterility, and to the degeneration of the whole species.

In their old nests and near the neighbouring colonies dwelling in the same locality, the bees of one colony might have some close links with other bees whose queen could have mated with their drones. The further away they fly from their old home during swarming, the greater and more reliable will their chances be to improve their hereditary traits by adding new fresh blood to their offspring, and to save the whole species from degeneration.

It is difficult to find two colonies living close to each other in neighbouring tree hollows in a natural environment. Man who had managed to bring wild bees together in one place, i.e. in his apiary, later had to work out special methods preventing his bees from inbreeding.

The bees' natural aspiration to have not one but several swarms should be regarded as their desire to preserve themselves in their offspring, to ensure the stable existence of the species. "To preserve the species," wrote Professor G. A. Kozhevnikov, "in its struggle for existence, it is much more important to have a great many small colonies than a few big ones. Each colony is a biological unit (integrity), and the greater the number of such units (integrities), the safer and more prosperous is the species, the better are its chances for preservation, even under unfavourable conditions."

With its act of swarming, nature has excluded another, equally serious danger, namely, the species' extinction from famine. If every new colony was able to settle only close to its parental one, then, within a very short time, the locality would be so heavily overpopulated with bees, that they would all be threatened with starvation. The nectar-bearing vegetation surrounding them would never be able to

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secrete such quantities of nectar which the bees would need for their existence and reproduction.

Furthermore when bee colonies scatter about a locality during settling, thus occupying ever new areas, their numbers are not concentrated in the same place and the local nectar plants are not overexploited by bees. Therefore, bees can normally feed on nectar from early spring to late autumn, and also forage it for winter and for periods which are not conducive to honey harvesting. Such stores of nectar may serve them for a long time, sometimes even for years.

Having found a new place to settle down, the swarm immediately gets to work: some bees clean the walls of the hollow, others construct their combs, still others fly away in search of pollen and nectar.

So, *the biological meaning of honeybees' swarming lies not only in the birth of new bee colonies, but also in providing the uninterrupted existence of the bee species.*

The swarm matures in the colony. During a certain period of the colony's life, a swarm—the fetus of a new colony—is conceived and formed.

Growing appreciably stronger after wintering, having refreshed its nest, the bulk of which is now occupied by the brood, and having replenished its food stores, particularly of protein forage, the colony seems to enter the time of its sexual maturity, its instinct of swarming acutely awakes now.

The first sign that the colony has passed from its old physiological state to a qualitatively new one is the appearance of the drone brood in the nest. Before this, the colony's life was governed by the instinct of reproduction, i. e. the multiplication of its offspring, chiefly females (working bees). During its growth, the colony, like all others, did not need any drones because the queen in a normally wintered colony is always fertile. Drones are not required for the prime swarm either; the old queen goes with it. When swarming, the maternal colony does not give away all of its bees but only part of them (usually one half). The number of those remaining in the colony increases daily due to the breeding of new generations. Later they may form two or three new swarms, and it will be along with them that young virgin queens will fly. In order to fertilize these young queens, the parent colony tries to breed drones. This is indicated by the fact that colonies entering winter with queens, which for some reason became sterile, do not expell their drones, permitting them to spend the winter together with their bees.

It is true that at first sight one may think that nature is committing a blunder by allowing a young queen to mate with her drone-brothers.

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But this one-time mating is not harmful for any colony. Queens and drones bred in one colony have different genetic backgrounds. Female individuals carry in them the features of their mothers and fathers, while male ones—only those of their mothers. Hence, their genetic bases are different. That is why the inherited characteristics of the future offspring do not deteriorate.

Mating between relatives, which might harm the inheritance of future generations, can be prevented and is precluded by the very act of swarming. Thanks to this process, young queens of each successive generation will mate with drones which are not their relatives.

Owing to huge numbers of drones bred in every colony, the air becomes saturated with male individuals of the most diversified genetic backgrounds. Now, it is guaranteed that mating will be normal not only in terms of the colony's own queens but for those from other colonies as well. The genetic background of future generations improves in general. From the point of view of biology, this is, perhaps, the most important thing providing for the preservation and prosperity of the honeybee species.

Before the instinct of swarming becomes strong, the queen passes by the cells of drones, but the bees completely ignore this fact. Now, during this new stage of the colony's development, they begin looking for such drone cells, cleaning them and preparing them for the queen's egg-laying. In case there are no drone cells in the nest (say, the beekeeper has sorted out all the combs with such cells), the colony will by all means build them itself. The desire to breed drones becomes so strong that, having no spare room for building drone combs, bees can even reconstruct bee cells into drone ones. The colony's drive for building drone cells cannot be prevented even by installing an artificial foundation in the nest. Since the bees will only use it to construct whole sections of new drone combs.

The drone cells prepared, the queen will lay her eggs in them. The colony continues its flights for pollen and nectar, and goes on breeding the brood. However, the number of fertilized eggs laid by the queen falls. Now the queen will most likely abandon her egg-laying and look for drone cells, spending a lot of time on this search, sometimes covering scores of meters per day. The colony continues to grow, and the mass of the bees expands daily.

There is only one change observed, that is in the construction of combs. Quite recently, the colony built combs of bee cells alone; now, most of its efforts are concentrated on building drone cells.

The colony lives in this state for some 12 to 14 days. During this period it produces large reserves of young bees. And then the moment comes when the number of nurse bees and that of larvae requiring

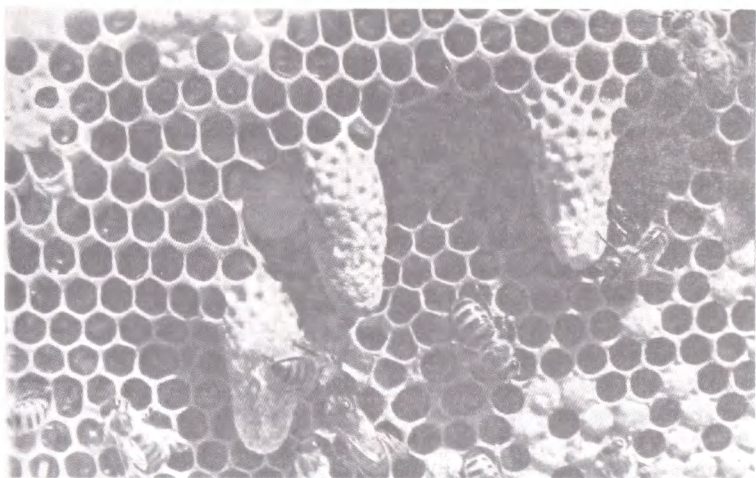
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A swarm.



A swarm which has failed to find itself a proper tree hollow.



Swarm queen cells.

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care and tending begin to disbalance. It is no longer only one or two bees that tend to each larva, but two or three that. Young bees cannot completely use the jelly they secrete for feeding the larvae, therefore their energy remains unspent and accumulates. Neither do young bees participate in comb-construction. It is true, their help there is not wanted, since the nest was already well built by the previous generations of bees.

The colony is in a state similar to that of pregnancy. It already has the formative material necessary to form its fetus, namely, its swarm. At this new stage of its development the colony is engaged in making a special kind of cell, different from both the bee and the drone ones. These new cells are round and cup-like in shape, and therefore they are called queen-cell cups. They are built to breed queens in.

Colonies build various numbers of queen cells, depending on the beebreed and the extent of bee swarming. But in all cases, they always build more than are necessary. As long as the cups remain free from eggs, the colony continues its normal working life.

All of a sudden, there comes a moment when the bees begin to carefully polish the internal surface of the queen-cell cups, slightly restructuring and narrowing them down to the diameter of a working bee's cell. They do so because the queen will not lay her fertilized egg in a broad cup.

According to a theory elaborated long ago, the bees narrow these cups so that, while laying her eggs, the queen's abdomen is pressed. It is believed that at this moment the spermia are reflectorily pressed out of the spermatheca into the oviduct, and in this way the egg gets fertilized.

Today biologists attribute the oviposition of fertilized and unfertilized eggs to the queen's ability to feel the exact size of the cells the egg goes into, as well as to distinguish the cells of bees and queens from those of drones to which she responds differently.

Before she lays her egg into a cell, the queen is known first to insert her head and front feet. She does so not to make sure the cell is clean, as was once thought, but determine the cell's diameter. The queen measures this diameter with her front feet, using them as if they were calipers.

If the cell is for bees or queens, the queen's reproductive system is affected by a special agent whose effect weakens and relaxes the circular muscle. The latter closes the exit from the spermaduct, permitting the spermia to enter into the oviduct. If the cell is for drones, the device closing the spermaduct does not function this way and the spermia do not enter the oviduct. Thus, the egg does not get fertilized.

If the colony has already collected its reserves to start new colonies,

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the bees compel the queen to lay her eggs into the queen-cell cups they have prepared. It seems most likely that the initiative for such actions is taken by the bees of the future swarm.

It has been found out that the eggs, which the queen lays into swarm queen-cell cups, are somewhat heavier than those laid during the colony's intensive growth. It is natural that bigger eggs contain more nutrients and their embryos can develop better. There is a saying that a good seed yields a good breed. Swarming queens are always reared from big eggs.

Today's biologists believe that the impulse for laying in queen cells is the shortage of queen's secretion in the colony.

With the development of the queen's larvae the activity in the colony gradually reduces. Just a couple of days ago the bees were foraging speedily and happily, they were building combs, though for drones, and the queen was laying her eggs rather regularly. And now only a few bees collect nectar, chiefly older bees; they are collecting pollen and water, which the still numerous brood, so far unsealed, requires. As if by a special signal, a great mass of bees, mainly young (about five to 20 days old) do not perform any jobs at all. They will have to leave their native nest to build a new one in some other place. The nest they are still living in is now overcrowded with bees and brood. Particularly many are the young bees in the lower storey of the hive.

The swarm is capable of building a nest for itself, of procuring the necessary food, and raising offspring within quite a short period of time. The offspring will be able to pass the gift of life to other generations next spring and ensure the colony's existence during winter only if it is comprised of bees capable of doing all these jobs simultaneously and at a high speed. The task can be tackled only by young bees which are physically strong enough and not worn out physiologically. To prepare them for their mission, nature timely (nine to 10 days before the swarm emerges) excludes the young bees from the colony's working rhythm. They are now absolutely indifferent to the vital processes naturally occurring in the nest while the colony prepares for swarming.

The queen drastically reduces her egg-laying. The retinue no longer pays dutiful attention to their queen and gradually disintegrates. The nutrition ration diminishes. It was believed that during this time the queen fed on the honey which she took from the cells herself. But recently it was discovered that she begs her food from the bees and they continue to feed her with their jelly.

Such an attitude of bees toward their queen is biologically justified. When she is abundantly fed on bee's jelly, the queen's sexual organs

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Nurse bees near an uncapped queen cell.



A queen with clipped wings.

simultaneously produce and develop huge numbers of eggs. Therefore her abdomen is occasionally very swollen, and she gains maximum weight. As the nutrition is then reduced, the activity of her sexual organs fades, her egg-laying is reduced and almost comes to an end. The queen loses weight and is now light enough to join the swarm in its flight, because an egg-laying queen, being heavy in weight, is unable even to fly up into the sky.

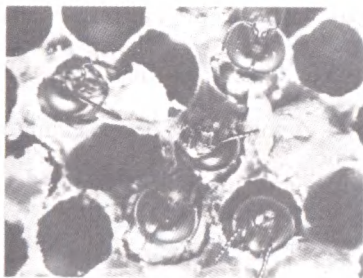
The rate and speed of egg-laying having slowed down, even though for a short while, the queen can now take a rest to be stronger and more capable of laying her eggs in a new nest later on.

Some drones go away together with the new colony, too, though it would seem that they are not needed, since the queen is fertile. But she may be old, some four or five years in age, and therefore not absolutely reliable. Nature also foresaw even this small detail in an effort to insure the propagation of the species. Furthermore, apparently it was in the distant past, when the species was still evolving, that parent colonies swarmed as well as swarms. One can see it today, too, especially in southern bees. In the south, where the warm season lasts long, as well as the period of plant vegetation, prime swarms are not rare. Finally, drones, having left their native nest along with the swarm, may prove to be more able to mate there, in a new place, with queens of different colonies, which is particularly important for the preservation of the species.

But the majority of drones remain in their own nest. They will be needed by their colony which, after swarming, was left in the nest with a virgin queen.

About half of the maternal colony remains in the hive after the departure of the first swarm, sometimes the number of the remaining bees may be greater. With every new day, this mass increases as new

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Drones are being born.



The queens dual. The victor is the younger queen which is stronger and more nimble.

bees are hatched. In about nine or 10 days the colony will be almost as strong as it was before swarming. Then it can easily let another swarm go, occasionally even two or three.

By this time, the swarming colony practically ceases its activity completely. And that is quite clear: the open brood has already been sealed, while the capped brood does not need any more tending, the food stores are still sufficient, though heavily diminished and unreplenished because of the swarm's departure. The colony is still driven by the powerful instinct of swarming.

The second swarm usually leaves the nest on the ninth or 10th day after the first one. During this period a cast (after-swarm) is formed if the colony let the first swarm go at a normal time, i. e. on the very next day after the first queen cell was sealed.

It is believed that when a sealed queen cell appears in the nest, bees regard it as a signal for the swarm to leave. All of its tasks in tending the queen cell have been accomplished. The swarm has been formed, there is nothing to prevent its departure from its mother hive. As to the second part of the colony remaining in the nest, its future is well guaranteed. However, this biological regularity does not always hold true: colonies of the gray mountain Caucasian breed and of the yellow steppe let their swarms go on the fourth or fifth day after the queen cells are sealed.

The departure time of the swarm depends on the weather, too. If the weather is suddenly getting worse, the departure of the prime swarms is delayed, occasionally for a couple of days, till a bright sunny morning downs. During this time, young queens mature and attempt to leave their cells by gnawing holes in the caps, using their sharp strong jaws. But to leave the queen cell is impossible for them, since the old queen and her swarm have not yet left the hive. Feeling

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the presence of other matured queen-daughters, the old queen gets irritated and tries to destroy them, but the other bees, guarding their young queens and feeding them through the cuts in the queen-cell caps, do not allow her to harm the others.

The mother queen grows angrier and, running from one cell cup to another, makes long and sharp sounds, such as pee-ee-e-pee-pee.

Young queens, in their turn, answer in an equally angry tone. But being inside the sealed cups, they sound somewhat dull, husky and hoarse, so their signals are like qua-qua-qua. This peculiar signalization has been named queens' singing.

With the swarm having departed, the colony at last permits one of the most energetic young mothers to leave her cup. Before the second swarm leaves the hive, this young queen behaves very much like her mother.

The swarming state may cease after the departure of the prime swarm (which is favoured by the onset of a good honey flow). Then the bees which were guarding their queens in the cell cups no longer watch them. Immediately upon their release, the queen will attack the cups, gnaw them from the side where the queen's (who is inside) abdomen lies, and through the hole so made will kill her own sisters, using her pestilent sting.

During the course of their evolution, the queen of honeybees has become extremely fertile. One queen is capable of creating a colony containing several scores of thousands of bees. And that is why queen bees began to hate one another.

Sometimes two or even more queens come out. They will inevitably meet in a life-and-death battle in which one of them will die. No more singing is heard. As G. A. Kozhevnikov wrote, "The instinct for extermination has, certainly, evolved as some secondary phenomenon; and it could develop only when the abundance of queen bees became excessive." Having remained alone, the surviving queen calms down. Upon reaching her sexual maturity (on the sixth or seventh day after her birth), she starts mating with drones, and the entire colony immediately begins working.

Intensively swarming colonies may produce as many as three or four swarms. Each successive swarm is always smaller in size than the previous one. New swarms appear at intervals of one or two days. This considerable difference in the appearance time of the cast and the subsequent swarms can be attributed to the time of the queens' development. The second swarm waits till the young queen develops, leaves her cup, gains strength and becomes capable of flying. The subsequent swarms do not have to wait till the queens develop. These queens become strong while still back in their cups obliged to remain

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there all the while their elder sister was maturing to leave the nest, and managed to leave her queen cell just a little bit earlier.

From the branch to the swarm box. As soon as the swarm settles on a branch or a bee bob, it is taken off. If the swarm has settled on a branch high above the earth, one has to use a ladder to get to it. An open swarm box is placed beneath the swarm and the bees are shaken off there by striking the branch slightly with one's hand.

The bees, which failed to get into the swarm box when the branch was tapped, are now permitted to reach it by themselves. To assist them, the swarm box is hung in the vicinity of the bee bob and a small passage is left open in its bottom.

A swarm hung on a thick branch or a fence, from where it is difficult to shake off, is removed by a wooden scoop and then carefully poured into the swarm box. The remaining bees are driven out into the air by smoke; they are permitted to fly into the box by themselves.

After the entire swarm has gathered in the swarm box, it is closed and placed to some cold and dark place (a cellar, a vault, a winter-abode) to be kept there till the end of the day.

On an out-apiary, without any cold or dark place, the swarms are hung up in the shade in the air current. As it gets cooler, the swarm quickly calms down, and soon there is practically no sound from it. If the swarm is very noisy, and the bees in it are scattered all over the swarm box, and many of them are running as if trying to escape from the network cell, it means that the swarm does not have a queen. Such a swarm will be used to strengthen a colony which has already swarmed and is involved in honey harvesting, or another colony which has not grown enough and is in need of flying reserves.

Swarms are placed into hives at the end of the day, as a rule, when the sun is setting and the bees have basically finished their flight over the apiary. One must keep in mind that the very moment the swarm is seated, it may immediately fly off. The swarm is still excited, the time for its calming down was too short, the scout bees are still informing everyone about the new home they have found. Besides, and this is the most important thing, the swarm so far has not yet satisfied its natural and extremely important biological function—it has not separated from its parent nest, has not yet flown far enough away from it. Leaving the hive where it was forced to settle, the swarm at once starts for the home which it previously selected for itself. And now, flying along a straight line towards its goal, the swarm will stop at no obstacle. It will not make any secondary settlement.

The hive must be well washed, free of any foreign smells; if these conditions are not met, the swarm may abandon it.

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In the apiary, the hive for the swarm is arranged so that the wood or brush vegetation can protect it against the sun during the hot part of the day. To facilitate the bees in building their new nest and to speed up this process, the beekeeper puts inside the hive some frames with light-coloured and light-brown empty combs free of drone cells, as well as frames with foundations and one frame with food, in case the weather suddenly changes for the worse. As a rule, one usually provides the swarm with three or four frames of Dadant-Blatt per one kilogram of bees, or five to six frames for multiple-storey hives.

When settling the swarm, one takes the bees from the swarm box with a wooden scoop and shakes them down onto a gang plank, at first somewhat closer to the flight entrance, and then, as soon as the bees start entering the hive, somewhat farther off. This makes the bees feel that they are entering the hive by themselves. At the same time, it is simply interesting to watch the bees and queen as they approach the flight entrance.

After the larger part of the swarm has entered the hive, those still in the swarm box are shaken off onto the gang plank.

It is possible to settle the swarm from the swarm box right into the hive and onto the frames. Then the bees will get used to the nest during the night and can even build some part of the combs. The next morning the swarm will make its flight and will immediately start to collect nectar. Any further maintenance of the swarm will be only to increase the nest area. An early swarm will turn into a new good and vital colony.

In apiaries where bees are permitted to swarm, there are frequent cases when such swarms get lost, having gone to nests they found themselves beforehand. When a beekeeper loses a swarm, he not only loses a bee colony, but he also loses at least 16.38 kg of honey and one storey of combs.

Prime swarms often weigh as much as 4 kg and more and, hence, are of great value. To prevent the departure of such prime swarms, beekeepers resort to clipping the queen's wings.

In spring, when the queen is easier to detect, her wings, the right or the left, are clipped with small scissors, to not more than half their size (the beekeeper gently holds the bee between his left index and big fingers, her chest and feet in his left hand, while with his right hand he clips the wing). Wing-clipping is not painful for queens and has no adverse effects on their egg-laying. But with her wings amputated, the queen will not be able to fly up into the sky, but will fall onto the ground from the flight board, and thus the swarm will return to its nest.

Some bees can find their queen in the grass rather quickly and then

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they gather around her in a ball. Surrounded with their care, warmth and love, the queen will be able to live for a couple of days.

Beekeepers, in their periodical inspections of the apiaries, often find these very valuable queens and take the necessary measures to return them to the nest.

The swarm is working splendidly. Many beekeepers who have their apiaries near their farms, favour the idea of swarming freedom. It is true that natural swarming, though undesirable as regarded by modern apiculture, gives one an opportunity to obtain new colonies which from the very first postnatal days are exceptionally efficient in whatever jobs they do, be that comb construction, nectar collection, or brood rearing.

Swarms which leave the nest early, some 45 to 50 days before the main honey flow, have sufficient time to build their nests up, to raise large broods, and to become considerably rejuvenated. It is true, they may not be strong enough yet to use the main honey flow, but in all others they can work just as strong colonies. And it is not without reason that beekeepers say: "An early swarm is a golden one."

Colonies, having let their swarms go, will be able to restore their strength before the first main honey flow, thanks to the bees from the reared brood which remained in the nest after swarming. The colony will also regain its working capacity after the young mother-bees begin their egg-laying. Over the course of time the colony will become still stronger, due to the bees which develop from the young queens' brood. And, as a result of all this, such a colony will be able to store plentiful food reserves.

The swarms which leave the colony right before or at the very onset of the main honey flow make sufficiently good use of it. Such swarms are usually heavier than early ones, because their parent colonies had a longer time to grow. Also, summer swarms usually work during the period of honey harvesting with much more zeal and energy and do it themselves, while early swarms usually entrust the task of honey harvesting to the generations they raise, but do not collect honey themselves.

However, harvesting the main honey flow, the summer swarms get worn out and weaker, and, as a result, the honey harvestings after the main flow are utilized by them much more poorly than by earlier swarms. Furthermore, later swarms, in contrast to earlier ones, rear considerably fewer new generations before winter. Such later swarms frequently have to replenish their stores of food, because those prepared after the first honey flow are exhausted by this time. It is common practice among beekeepers to unite these swarms into one col-

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ony, joining two or three of them together. It is also frequently the case that such mighty colonies are naturally formed during swarming. The first swarm may then act as a graft for a second one, and occasionally even for a third. Such cases are usually observed when swarms are delayed in their departure due to bad weather. A swarm of this kind is known as a dump one. Dump swarms are difficult to separate, sometimes it is even impossible to divide them, and practically speaking, it is not even feasible. In view of this, such swarms are brought into one large hive, having special extensions for honey. Strong bee colonies, born from natural swarms, are called honey-rich for their high productivity.

Parent colonies which let their swarms go not long before the main honey flow, have no time to provide new flying reserves. Furthermore, as a rule their swarming state lasts longer.

When swarming occurs during some average period of time, say, two or three weeks before the main honey harvest, swarms have sufficient time to build up their nests and to rear heavy broods. However, their collection of honey and pollen is poor, since during the first main honey flow the larger part of the bees is taking care of the brood, on which much of the fresh food is spent.

Parent colonies have sufficient time to come out of their swarming state before the honey flow; the young queens will have mated by that time and started laying eggs. They will work with the energy typical for a swarm but will still be weaker than some non-swarming colonies; hence, they will naturally prove to be less productive.

It is better to settle swarms which have left the hive on the eve or at the beginning of a short and mighty honey flow on combs built up and prepared beforehand. In this case, all reserves in the swarm will immediately begin honey collecting. If the swarm is first settled on a foundation, it will primarily engage itself in building its nest, and thus it will use the honey flow only partially.

Swarms which are not strong enough will not be able to yield commercial honey independently. So, at the beginning of the honey harvest, such colonies are usually joined to those which by this time have already finished their swarming and are only engaged in collecting the honey flow. In other cases, weaker colonies can be employed to strengthen the flying reserves of other colonies. Swarms can be joined to others either as whole units, or in parts, by adding small groups of bees to several colonies.

To preclude any possibility of the queen's death in a colony so strengthened, the bees of the swarm are poured into an extension with its bottom made of a removable screen. The queen is used as one sees fit.

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In a colony which has passed its swarming state and is now engaged in honey harvesting, there may be no open brood by this time, or else it may be there but very scarce, because the young swarming queen hardly managed to mate and start her egg-laying. Now, strengthened by another swarm, it will be mostly composed of bees capable of gathering honey. Such colonies are precisely the ones that become honey-rich.

The productivity of swarms can be augmented by strengthening them with extra flying reserves and a sealed brood which may have remained in the parent colonies. To this end, the hive with a swarming colony is set aside and replaced with another hive which will receive a swarm, and populated with bees. On the next day this hive will attract other sister-bees. In some two or three days, the frames with already mature brood ready to leave from the parent hive will be brought to the new swarm. The hive with the remaining nest and old bees is set closer to that of the new swarm. It is not necessary to leave large reserves in the parent colony since its main function is to preserve the young queen for a while and to rear her brood.

With the honey flow over, and before the apiary is transferred to a new location with fresh sources of honey, the parent colony is liquidated by joining it to the swarm. The old queen is killed.

Not all colonies swarm The propensity for swarming is not uniform in honeybees. The strongest swarmers are regarded to be the yellow Caucasian bees which quite recently inhabited the area along the Kuban river; the swarming ability is lower in the Middle-Russian forest bees populating the territories of central, northern and north-western Russia, the Urals, Siberia, the Far East. The swarming ability is low in the gray mountain Caucasian bees, living in the mountains and ranges of the Main Caucasus Range, as well as in the Carpathian bees (dwelling in the western Ukraine).

Each breed of bees develops historically under the influence of the local environmental and climatic conditions. In certain populations, one may encounter colonies which for many years may not swarm at all.

Unswarming colonies are particularly numerous among the gray mountain and Middle-Russian bees. As a rule, these colonies harvest much more honey than those which live under the same honey-harvesting conditions but do swarm. From the point of view of practical beekeeping, it would be ideal to have an apiary composed of unswarming colonies. Then, our labour expenses for maintaining such an apiary would be minimal, while the results obtained would be maximal. Even though this contradicts the nature of honeybees, such an

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arrangement would not threaten the existence of the species. This act of natural reproduction, namely, swarming, can be replaced by artificial swarming. And it is in this very direction that apicultural science is advancing today.

The working rhythm in unswarming colonies is smooth, their instinct of reproduction dominates over all of the others until the plants participating in the main honey flow begin abundantly secreting their nectar. In this case, the reproduction instinct no longer rules, it is still strong but already of secondary importance. The primary role is now played by the instinct to accumulate honey. The swarming instinct in such colonies does not even get sharper. And, nevertheless, unswarming colonies, like all others, can produce their own offspring under certain circumstances.

The capacity for swarming is an inherited trait of all honeybees. Unswarming colonies also build drone combs, though in much smaller quantities. They also carefully rear drones, and occasionally even prepare queen-cell cups for future swarm queens. But for their instinct of swarming to become sharper and dominate over that of reproduction, special conditions must be met, which do not exist in nature at a given time as they should. And when the main honey flow and harvesting begin, particularly when they are hectic, the swarming instinct fades not only in colonies which do not swarm but even in most intensively swarming ones.

“Swarming is one of the central phenomena in the biology of bee colonies,” wrote Professor G. A. Kozhevnikov. “In this phenomenon, weaved together in a complex and hard-to-untangle ball, are the inborn instincts of bees and the diversified external conditions which favour the manifestation of these instincts, or, on the contrary, hinder it.”

So, it means that the swarming instinct can be influenced, and consequently, to some extent, governed so that its effects are augmented if swarming is desired or weakened and even retarded and destroyed if swarming occurs shortly before the main honey flow or partly during it, and consequently the apiary may remain honeyless.

What sharpens or dulls the instinct of swarming. In their observations of colonies' growth and development, beekeepers have almost inevitably found swarming to occur in colonies living in small hives and cavities or in hives strongly heated by the sun. Swarming is also typical for older nests and those containing many drone combs, whose queens are old, not less than three or four years in age, and of low fertility.

The instinct of swarming reveals itself most sharply, even involving

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whole apiaries, in years with a mild and warm spring and a hot early summer.

When the spring is favourable, colonies accumulate large reserves of bees, and find then that the main nectar plants are still not blossoming, while secondary ones are already producing their nectar but too scantily, under these conditions colonies would naturally not let all of their young reserves participate in honey gathering. The bulk of strong bees would keep to their hives.

Bees reduce their flying activity; their nests become stuffy due to overpopulation and the increasing seasonal heat. Under these conditions the instinct of swarming is encouraged and becomes sharper.

To combat swarming, a number of anti-swarming techniques have been elaborated by beekeeping practice and science. The complex of such methods includes some to prevent the instinct of swarming or suppress it in case it does reveal itself. All of these anti-swarming techniques can be applied to colonies in any type of frame hives, though their effectiveness may differ greatly.

When the colony is growing and actively gathering honey, building combs, rearing the brood, all that strain prevents the instinct of swarming from gaining command over the colony's life. This state of growing can be prolonged by loading all the bees with work, particularly those which are young and engaged in nursing the brood and building combs.

Both of the latter jobs, unlike any others, demand huge energy expenditures. And if bees' energy is spent only partially, it naturally accumulates. It was discovered that at this time even the sexual system in nurse bees begins functioning (their ovarian tubules gain in volume). Biologists attribute this phenomenon to the hormonal effect of the bee jelly which in great quantities remains unused in the bee's organism. They turn into anatomic drone-laying bees, as biologists call them. Their working activity gradually diminishes. It is suggested that these very bees, which now begin to work less and less, are the ones that will form the nucleus of the future swarm.

The more jelly the colony produces and the less it uses (there is little open brood in the nest), the earlier the instinct of swarming manifests itself, and the greater the colony's desire for swarming.

The colony will develop normally, and its instinct of swarming will not excite it, if for each nurse there are two or three young larvae. With the colony getting stronger and growing, the amount of work for its nurses gradually reduces to a minimum. There will come a time when the numbers of nurses will exceed the quantity of open brood by five to 10 times. This quantitative discrepancy between the brood and the young bees occurs, as a rule, in every colony of honeybees, but its

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timing differs: it can be observed earlier in colonies whose queens are of low fertility, somewhat later in those with queens of average fertility, and considerably later in colonies having highly fertile queens.

Every queen has a certain egg-laying limit. Some of them, due to their heredity or rearing background, cannot lay more than 1500 eggs per day; others with better inborn qualities are capable of laying 2000 to 3000 eggs if raised under particularly favourable conditions. Sometimes there are queens with an extremely well developed sexual system and a still higher fertility. Every egg-laying queen sooner or later reaches her egg-laying maximum, after which she lays almost exactly the same number of eggs daily. Young bees will go on accumulating their mass (the colony will continue its growth) long after the queen reaches her maximum egg-laying limit. This results in great overproduction of royal jelly. The sooner the queen reaches her limit in egg-laying, the earlier the drone-breeding queens appear in the colony, and there will be conditions favourable to awaken the swarming instinct. This critical state is most likely to be the earliest in colonies whose queens are of low fertility. As a rule, this state coincides with the period when the natural honey flow is steady but weak. So, the colony cannot be sufficiently loaded with work but it also feels confident that from now on it will not starve to death, and neither will its offspring.

For colonies whose queens are of high fertility, this hard time is not so dangerous. The instinct of swarming may not sharpen in them. In their case, the poor honey flow of this period does not hinder their queens' egg-laying but on the contrary promotes it. A queen with greater potential will speed her oviposition, and will respectively charge her nurses with more and more work. By the time the queen reaches her egg-laying climax, the period of stronger honey flow will have begun in nature. In some areas, this will be the period of the main honey flow. Now, honey will be gathered not only by older bees, but also by many young ones. The job to process the nectar into honey will also be more demanding. And in this way, the instinct of swarming will not intensify in the colony at all.

The quantitative discrepancy between the colony's nurses and young brood and hence the conditions for the swarming instinct to surface are inevitable. Such conditions will become a reality rather soon in small hives with limited numbers of combs. In spring, when queens lay few eggs, such hives are suitable even for strong colonies. However, queens, particularly those of high fertility usually fill in all vacant combs with their brood, doing it too quickly, not using their full potentials. This happens before the egg-laying queen reaches her biological limit in oviposition. It often happens in colonies living in

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large hives where the brood parts of the nests did not change and many combs are very old or for drones. The queen will not always lay eggs in such combs, and if the cells contain beebread or are wrongly built, the queen will simply pass them by.

Swarming is not profitable. Natural swarming of bees allows the species to settle in new places and maintain its existence over millions and millions of years. Nevertheless, it is not profitable in rational beekeeping.

“It must be remembered that the goals aspired to by nature and by man are not the same,” wrote A. M. Butlerov. “For nature, the goal is to preserve the colony, and for that it is quite sufficient if the number of its bees has increased during the summer so that it can survive the winter, the reserves it has stored being adequate. If in addition to this the colony has managed to swarm in the summer, then all the tasks set by nature can be regarded as accomplished completely. But the desire of man is different... His goal is to obtain as much honey as he can.”

A swarming colony gathers two or three times less honey than one whose swarming instinct is dull or has not awoken. There are many cases when swarming colonies even fail to store the amount of food they need for winter.

In fact, colonies preparing for swarming virtually do not do any work for three to four weeks. If this period of idleness coincides with the honey flow preceding the main one, and very often with the main flow itself, swarming colonies fail to utilize it as well as unswarming ones.

“Bee swarming,” wrote N. M. Vitvitsky, a famous Russian beekeeper, “is almost the same thing as a wedding in a peasant family during the hot working time of summer when the peasant must do his best and hurry up to complete his hay-mowing and reaping before bad weather begins; but, instead, he is engaged in preparing his wedding feast. In the same way, bees swarm during the time which is the best for honey harvesting.”

The swarming instinct develops in colonies which have completed their growth and collected their reserves, in other words, in ones which are strong. But nature has endowed with this method for reproduction (swarming) not only strong and productive colonies, but those of low productivity too, and these swarm even more frequently. Swarms of such weak colonies, while settling over the area or remaining in the apiary, pass their poor heredity through their drones to queens of good inborn qualities, thus reducing the economic and commercial value of these bees. In this way, the freedom to swarm

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granted to bees in one apiary may hinder the breeding work of many beekeepers whose apiaries are situated within the flight zone of drones from swarming colonies of low productivity, i. e. within a range of seven to 10 km.

Colonies enter the state of swarming at different times, even though they might be about equally strong and kept under similar conditions. Therefore, the period of swarming is not measured in days but in weeks. It is also worth mentioning that swarms go out at different hours of the day: primary ones—more frequently in the morning, before lunch, and if the weather is variable, at an hour they find most favourable during midday; secondary ones, and moreover those after them, may depart later, even in overcast weather if it is not raining.

The beekeeper, if he does not want to lose his swarm and let it fly away, has to stick to his apiary from day to day for almost a whole month. And how many of us can spare so much time? Can each and every amateur beekeeper arrange his annual vacation so that it coincides with the swarming time of his bees? And it is still more difficult to watch and guard one's swarms if the apiary is migratory and at the moment is far from home.

Natural swarming results in many additional and labour-consuming jobs. To prevent a colony which is preparing for swarming from rearing large numbers of drones, especially those of a bad strain, the beekeeper has to open the nests frequently, inspect the frames and cut off some pieces of combs containing the drone brood. However, this does not suppress the colony's desire to rear drones, but on the contrary, augments it even further. The bees immediately build up such cut-out spaces with new drone combs, while the queens will immediately lay their eggs there. This operation has to be repeated, but the bees will again construct drone combs in place of those removed.

In order not to disturb the bees, many beekeepers cut out drone combs containing not the queen's eggs but pupae, i. e. brood that is already sealed (capped). True, this saves one's labour, but the expenses in honey and in the colony's energy are not justified at all. While rearing the drone brood, the nurse bees are distracted from other jobs, which are much more expedient in terms of practical beekeeping.

With the drone brood removed from the colony, it gets upset and its flying activity decreases. Its response is even more agitated if the beekeeper takes out not just some pieces of the drone brood, but cuts off the caps sealing it together with the pupae heads. The bees then hungrily attack the dead bodies and suck the haemolymph out of them; the remains of the pupae are thrown away from the cells and discarded from the hive. Such rude interferences are very painful to

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the colonies, bees become wildly irritated and angry; they cannot restore their normal working rhythm at once but only after a rather long interval. All this testifies to our inability to rule the bees or to govern their nature.

At a later time, when the colonies have already let their swarms go, it is necessary to cut out the extra cells of swarm queens.

It takes a lot of time to brush the swarm off, especially if it has suspended high up in a tree or in an inconvenient place. It is also a long procedure to seat it into the hive. It is also quite possible that the swarm will leave for good.

The beekeeper is spared of all these operations if the bees do not swarm in his apiary. Their productivity would be much higher. And means to prevent swarming do exist.

Natural swarming is said to be the poetry of beekeeping. And, indeed, one cannot help admiring the picture of bees swarming. But, as it was justly stated by P. L. Snezhnevsky, a well-known Russian beekeeper, "... at present, the highest poetry of beekeeping is the highest gain one can get from his bees, and their low productivity is the duller of prose. If one weighs everything, the result will be that the genuine poetry is not in bee swarming but in the noise of the honey extractor at work, and in the abundance of little tubs filled with honey. And they are filled in when the colonies are not in a swarming mood."

To prolong the colony's growth means to prevent its swarming. To promote the continuous growth of colonies and not to limit but, on the contrary, stimulate in every possible way the queens' egg-laying, the nests are enlarged in early summer when the instinct of swarming is not yet strong. The nests are made not of brown combs, as in spring when the colonies are growing, but of light-brown and completely light ones yet without any brood whatsoever. For such nest expansion, frames with foundation are used (at this stage of a colony's growth, queens are more eager to lay eggs in freshly built combs).

There are also some special techniques which can be employed for maintaining colonies in good working condition. It is extremely important to see that the bees and queens do not exist for even one day in a tight nest where there is insufficient room for movement.

The beekeeper does not interfere in his bees' life too often, as recommended by the rules of rational apiculture. Therefore, he does not always notice the moment when the size of the nest begins to hinder the work of its bees and queen. So, it is better that its size is always somewhat larger than required by the bees, containing some reserve space for the colony's growth.

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If the colony has not yet occupied a 12-frame hive, the frames which are not required are still installed at once, not near the end combs with the brood, as was the case in early spring, but in the middle of the nest, right in front of the flight entrance. The nest is now enlarged by using a foundation and not the empty combs.

Arranging the foundation frames in front of the flight entrance, one divides the nest into two parts, with about half of all combs containing brood and food in each of them. Besides, in this way the colony is mobilized for its construction jobs: due to their very biology, bees cannot adjust to their nest being divided, and do their best to restore its integrity as fast as they can, to fill its emptiness with combs and fill the latter with brood. Bees draw upon considerable reserves in such construction jobs. Soon, the queen also comes to the new building site, attracted by the fresh combs and the energy of the bees. The bees can hardly manage to finish their cells when the queen immediately starts laying her eggs there. The middle of the nest steadily receives fresh air through the flight entrance. Since fresh air is badly wanted by the whole colony and the brood, the most favourable conditions for comb-building and egg-laying are usually found in the very middle of the nest. Engaged in these jobs, the colony seems to forget for a while that the time for drone rearing has come. Now the instinct of reproduction has again become the leading one in its life, and that of swarming, which was just beginning to gain force, fades for the time being.

Colonies, which by the onset of garden blooming will have completely occupied the hives, will receive magazine extensions or second storeys. Both the former and the latter are provided not only to accommodate the fresh honey expected, but also for scattering the bees and thus guaranteeing them better conditions for the further growth of their colonies.

In the nest of a 12-frame hive, which is small, the queen physically cannot work incessantly with all her might. One has to use the magazines for the brood, too, though they are primarily designed for honey storage and because of their low combs are inconvenient for queens. Such magazines are installed not with nine or ten frames as usual, but with 12.

The magazines are equipped with combs fit for the brood (the cells must be those of bees, unswollen and properly constructed). In the middle of such magazines, several frames with foundations are placed. It is not recommended to substitute combs for the latter, though many beekeepers do it. Such order may elongate the comb cells between which the foundation frame is placed, and the frame may be filled in with an inferior comb (its cells will be shorter). In this

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case, all three combs will prove to be unfit for brood rearing. To encourage the bees and the queen to move upstairs faster, some of the frames put inside the magazine are filled with small reserves of honey.

This rule is of particular value when applied to a colony of medium strength. Unlike a strong colony, a medium one prefers to stick longer to the brooding part of the nest. The honey placed above the brood acts like a kind of barrier for its bees and queen.

If such a colony receives a magazine with honey-free frames, it will not enter the magazine at once, but rather will remain in the nest, though the latter has become too crowded for the queen. The colony's growth will thus be retarded, and its swarming instinct will intensify.

A hive with one magazine extension is enlarged by using a second magazine with six frames (three placed on each side) containing empty combs and six frames with foundations (placed in the middle). The extension is placed between the storey and the magazine with the brood. Enjoying the volume of a 12-frame hive, the colony will be able to grow normally until the onset of the main honey flow. There is one thing to be seen to: the queen must have an opportunity to use the combs not only of both magazines but of the storey, too.

Instead of magazines, one can install second storeys. To this end, three frames with brood, no matter how good or bad it may be, are removed from the middle of the nest and installed in the second storey which is preliminarily placed onto a flat roof. The frames withdrawn from the lower storey are replaced with the same number of frames containing foundation.

Then the second storey is arranged upon the lower one. The upper part of the nest is thus formed. Near the wall which is warmer and better heated by the sun, one installs a frame with honey and bee-bread, and close to it those with the brood and empty combs, then again a comb with honey and bee-bread. The part of the storey so filled in is isolated by a partition. The combs in the upper storey and in the open part of the lower one are covered with two little pieces of canvas or with one longer piece. Warming quilts are placed into the vacant part of the storey and over it.

Arranged in this way, the bees' nests are left in peace until the end of garden blossoming. During this time the bees will be able to build combs on the foundation, the queen will gain new area of combs for her, and the colonies will get stronger. To encourage bees of all ages to fulfil the jobs characteristic for them even though the garden blossoming has ended, the nests are enlarged once again. The foundation (two frames) is installed in the upper storey close to the end frame with the brood. During a subsequent enlargement, the upper section of the nest is opened wide to install in its middle a frame containing a

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foundation. The division of their nest will again mobilize the worker bees and the whole colony for new construction jobs.

As a rule, the queen goes on laying her eggs in the upper or middle part of the hive. The combs in the lower storey, which is now free from the brood reared by the colony before its nest was enlarged or expanded, remain empty (the queen usually does not move there) or are filled in with beebread, particularly in areas rich in nectar plants. But even in this sufficiently large hive, the nest may again prove to be crowded because the brood will have room only in its upper part. The colony's growth will be retarded. To prevent any augmentation of its swarming instinct, order of the hive parts is changed: the magazines with the brood are moved downstairs and the storey lifted upstairs. The procedure is the same for 12-frame two-storey hives with removable bottoms.

Some beekeepers believe that changing the order of the hive storeys or of the nest parts provides vast opportunities to influence positively the growth of colonies and to prevent them from swarming. In hives with magazines, the following technique is also employed.

After the queen fills the first magazine extension with her brood, one withdraws from it six frames and puts them into the second magazine, three of them on each of its sides (those with honey are installed at the edges, those with the brood in the middle). The procedure is repeated with the frames remaining in the first magazine. Then the second magazine is placed onto the first one and the six nest frames (three of them containing foundation) are installed in the middle of both magazines.

Such dispersal of the brood, and the fact that the foundation-containing frames are now in the very middle of the upper storey, compels the colony to keep there not only its reserves of nurse bees but also its mason bees. In this way, one provides conditions most favourable for the queen to work.

With the frames filled in with brood, both magazines are removed, the six honey-beebread frames are withdrawn from the lower storey and in their stead the nest frames with the brood removed from the magazines are installed in the middle of the nest. Then the magazines are returned to the hive and filled in with the nest frames fit for the brood (they are not packed with beebread), or otherwise, with new frames with foundation or empty combs.

The bee nest in a long hive is usually expanded in the same way, i. e. by dividing it into two parts and placing foundation frames between them, right in front of the flight entrance.

In recent years, it has become rather common practice to enlarge nests only once. Following this technique, the end frames with honey

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and beebread situated close to the partition are pushed to the hive wall. The space between these frames and the exposed brood comb is filled with combs (at best, they should have little honey) and foundation frames. It is important to see to it that most of these frames are exactly opposite the flight entrance or in its vicinity. On the way to their working places through the flight entrance, the bees will encounter brood-free combs and sheets of foundation and will begin putting their nest in good order; and soon the queen will also move there.

Practice has shown that the strongest anti-swarming effect on the colony may be gained when its nest is expanded by breaking its brooding zone into two parts.

In a multiple-storey hive, the nest is expanded not by using separate frames but by means of a whole storey previously filled in with combs of low honey content (by two frames on both sides of the storey) and frames with foundation (six frames in the middle). If a colony is developing well, its brood is for the most part open and it builds its combs fast, when the conditions are especially favourable for honey harvesting, a storey with eight foundation frames and two with honey and beebread can be installed at their sides. This storey is arranged on the top.

If one notices that the drone combs are filled with sealed brood but the colony is still eager to rear more and more drones, that it is rebuilding the cells of bees for those of drones and is preparing queen-cell cups (which can be detected by lifting up the storey from behind) – it means that the colony's instinct of swarming has become acute. To prevent it from dominating the colony's life, one should install a third storey in between the first two brood storeys, but before that their order should be reversed. The flight entrance in the upper storey, where the honey is concentrated, must be closed.

Any division of their nest, particularly such a significant one, drives the bees into a state of stress and nervousness. The fact that one part of their brood is separated from the other by such a great distance, as well as the empty zone formed inside their nest, destroys the foundations upon which the very life and well-being of the colony previously rested. The bees cease flying for a while, but the overall activity of the colony increases.

All bees capable of excreting wax and of comb-building now concentrate their efforts in the disordered part of the nest and immediately begin restoring its integrity. For the colony there is no other task to tackle as important as this, and it is the instinct of building that now becomes the leading one. Within a short time, the bees fill in the

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gap between the parts of the nest with fresh combs. The queen moves into this newly rebuilt part of the nest to remain there until all combs with the brood are filled in.

With the storey installed in the middle of the nest, the colony is again dominated by its instinct of reproduction. The bees resume their flights for nectar and pollen, and even increase them; still more groups of young bees get involved in brood-tending. The rhythm and amount of work steadily increases. At this time the colony can be compared with an accumulator spending the energy it has stored. And it is difficult to say whether it is the field or the hive bees which are spending more energy now. The state of swarming gradually fades.

Describing a swarming colony which has almost ceased all activity, N. M. Vitvitsky wrote that "in one's spare time it is of great use to place an empty little hive (as he called each storey,—author's note) between two others filled with the honey and embryo in which the bees are ready to swarm; then the bees will forget about swarming and instead, with all their might, will try to fill the empty little hive placed between the completely full ones—such is the nature of this insect."

The technique of dividing the brooding part of the nest not only increases the colony's activity and the queen's work, but simultaneously eliminates the factors which before favoured the swarming instinct, namely, the excessive crowdedness of the bees on the combs and the stuffiness in the hive. These two factors disappear after the colony restores the integrity of its nest and the bees can freely settle in all three storeys of the hive.

The division of a brooding nest into two parts is a very effective anti-swarming technique. The results are the highest in multiple-storey hives where the area of division is much greater, as compared with a long or a 12-frame hive. When three or four frames are installed in a long hive, large numbers of bees, either in the left or right part of the nest, may enter and leave it, avoiding the zone of the gap and proceeding normally with their work. In a multiple-storey hive, the zone of emptiness occurs in such a place which no bee can pass by.

The bees in the top of a vertical nest cannot leave the hive without passing through this uncompleted section. The field bees and nectar foragers from the lower storey also must pass through this zone when striving to store the fresh honey that they bring to the top of the hive (this biological peculiarity is characteristic for most bee breeds). The bees hatched in the lower combs also move upward. Thus, the empty zone is a place where bees of different ages constantly meet.

The storey with foundation seems to divide the colony's home into two independent nests. A colony, having one queen, cannot live in

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two nests simultaneously, and that is why it tries to unite these two dissected parts into a whole integrity as fast as possible.

While the colony is building up the middle of the nest, all its activities are concentrated there. These emergency jobs never cease either in the daytime or at night. The bees accomplishing other functions at the time (field jobs) get an additional charge of energy, so to speak, when passing by this zone from the bees working there.

So, enlarging the nest by adding new combs to it, especially to its central part, can considerably activate the colony's life, prolonging its growth period. In other words, it enables the beekeeper, to some extent, to govern the instincts of his bees, mainly that of swarming.

Anti-swarming (shook swarms) nuclei. The growth of colonies may be effectively strengthened and prolonged, and the instinct of swarming well prevented, if one employs anti-swarming nuclei, as shook swarms or artificial swarms are called. In modern apiculture this technique is thought to be radical in preventing swarming. The timing for setting up such nuclei depends on the qualitative state of the colony. An artificial swarm can be separated only if the colony is strong. If it is not mighty enough and shows no signs of swarming so far, one must not remove any of its bees and brood, because then it will become weaker and its growth will be retarded. And, on the contrary, if the bees have already started rearing their swarm queens, one has missed the proper moment for separating an artificial swarm.

A colony considered to be ready for artificial swarming when its nest, composed of two or three storeys in a multiple-storey hive, is completely full of bees and brood, as well as of a mature brood of drones.

The procedure is as follows: the hive is opened and for one or two minutes a strong layer of smoke is jetted from its top along all bee streets. During this time, as a rule, the queen and part of the bees from the upper storey move downward to the lower part of the nest. Then the upper storey is taken off and put aside. The opened nest receives a blank ceiling. The hive is turned 180°, then the withdrawn storey with the brood is placed on its top, and a queen in a cage is introduced, preferably a fertile one.

The disturbed bees and those returning from their flights fuss around and near their hive. Failing to find the flight entrance in its habitual place, they begin to circle the hive from all sides. Some of them enter the flight entrance of the artificial hive which is situated in the same general area but somewhat higher, others discover their old flight entrance. The bees get distributed almost equally between the artificial hive and the colony with the queen. Thus, they are flying for

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about two or three hours. Basically, what happens is that the colony gets divided into two halves.

Beginning with the very first minutes, the colony and the nucleus, having both bees and brood of all ages, each start an independent and normal life. Upon providing them with second storeys, the nucleus is withdrawn and placed in the rear section of the hive practically right up against the wall. This arrangement facilitates tending the bees.

If the beekeeper withdraws too many bees and too much of the brood from the main colony, he may weaken it. The same quantity of bees, now distributed between two colonies, will have to raise the offspring not from one but from two queens. The burden for the nurse bees will thus double and the instinct for swarming will not increase in the parent colony.

When the main honey flow starts, it will be in a good state to work hard. If the swarming instinct did awaken in this colony, it will now diminish. The colony returns to that qualitative state which it enjoyed. The time for its biological maturity is prolonged and will continue as long as the colony needs to restore the reserves withdrawn by the beekeeper for his artificial swarm.

When organizing an anti-swarm nucleus which is biologically sound, it is possible to employ a technique permitting the parent colony and its nucleus to communicate. The queen is driven from the second storey into the lower one. Then the second storey is removed, carefully put on the overturned roof, so as not to smash the bees which may happen to be downstairs, and the lower storey receives a new one with a whole set of combs and a foundation; it is covered with a ceiling having a hole covered by a screen board. The withdrawn storey is returned to the hive, but now its flight entrance is in the rear part. The nucleus is provided with a queen.

After this operation the bees of the parent colony get distributed over all three storeys; the crowdedness in the hive and the danger that the swarming instinct can again govern the colony are eliminated.

If the nucleus and the parent colony are divided by an almost blank ceiling and a storey with empty combs, then there will be two independent and isolated colonies. When the young queen of the nucleus begins to lay eggs, the isolation will be more pronounced; the bees of the nucleus will fly through the flight entrance into their own nest, though the bees of both colonies will go on communicating through the screen in the ceiling. And, so far, no excessive reserves of nurse bees have arisen.

The bees carry the unsealed honey from the lower storey into the second one, and it is there that they store the fresh honey. Now the queen also moves into the second storey to work there. The vitality in

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the parent colony rises. It looks as if the colony is returning to its growth stage.

It is not necessary to supply the nucleus with extra food or water, and to strengthen its reserves with new bees. Its young queen will lay eggs very actively from the very first days.

In apiaries with 12-frame and long hives, the procedure for making temporary anti-swarm nuclei is different.

In the morning, when the field bees have gone to work and mainly young bees alone remain in the hive, the beekeeper removes the part of the nest with the brood (which is ready to leave), bees and food (honey, beebread) and puts all of this into a new hive (in long hives, behind a specially installed blank removable board). Such new hives are usually small, consisting of three or four frames, occasionally of five or six.

One brushes bees from two or three more frames with uncapped brood (there are more young bees there) into the same storey, the nest is surmounted by removable boards and then warmed up well.

Along with the young bees from the parent colony, many of its old ones also get into the nucleus; driven by their instinct to return home, they will soon turn back to reach their old nest. And then only young bees will remain in the nucleus. During the first three to five days they will be, naturally, unable to supply themselves with water which is so necessary for their life. In view of this, while the nest is still undergoing formation, one of its combs is filled with water (about one glass) or some liquid food (one part of sugar per three parts of water). Before the flights assume their might, such nucleus will be biologically inferior. Its bees will be unable to guard their nest properly. Therefore its flight entrance is made small to let in only one or two bees.

After the old bees return to their parent nest, the nuclei are provided with queens, desirably fertile and reared in bee-nurseries, or those which have spent the winter in their own apiaries; in case either of these are not available, one can use virgin queens or install mature queen cells.

Trying to be very careful with the queen cell, so that it does not get smashed or crumpled, one places it in a cell or between the two upper rods of the middle frames containing the brood. The temperature there is the highest and most uniform and therefore the queen will well develop to maturity. The queen cell is arranged vertically, at a slight angle. It will help the beekeeper check the exit of the queen without opening her cell. The young queen is placed in a little cage inserted in one of the middle streets.

It is better to place the queen cells and the queens into the nucleus no later than 2 hours after its formation. It is of vital importance not

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to delay this operation, since feeling the absence of the queen, the bees will hurry to set emergency queen cells on larvae which frequently occur even on frames with mature brood. Upon laying their queen cells, the bees would later reject both the queen and the queen cell till they seal the very last larval cell and remove the emergency queen cells.

Virgin queens and queen cells are provided to small nuclei which do not require great strength until the brood appears in the nest. After the queens begin egg-laying, the nuclei are strengthened with two frames of mature brood. Further on, the nuclei will develop by themselves and the only thing they will need is to have their nest extended two or three times.

Using infertile queens in nuclei, likewise queen cells, is rather disadvantageous. Due to bad weather, it often happens that the mating of queens gets delayed and, as a result, the nuclei fail to rear the number of bees they need to begin proper honey harvesting. It is also possible that during their nuptial flights, some queens may perish or get lost.

Nuclei, which are to receive fertile queens, are formed so as to be stronger, because soon after they receive their queens they will have to rear the brood.

Anti-swarm nuclei are not only reliable to prevent swarming. The fact that some bees and brood of the parent colony are removed speeds up the queens' work; the parent colony's growth is prolonged, and the nuclei provides considerable reserves of bees and brood. When the main honey flow begins, these reserves return to their parent colony whose productivity thus greatly increases. Simultaneously, the old queens are replaced by young ones.

Colonies exchange their bees. Swarming can be prevented if the old bees of a colony expected to swarm are exchanged with those of a weaker colony which is still growing. But this technique can be employed only when the natural honey flow is good.

Its field bees having flown off, a strong colony obviously grows weaker. It goes without saying that together with field bees some of those working in the hive also leave it. They have already gotten oriented with the locality but were still busy in the nest. Now, with these bees gone, the colony feels its loss badly (say, for example, the colony gave 2 kg of bees but received back only half a kilogram), the jobs are redistributed between those remaining in the hive. With their numbers decreased, their load becomes greater, particularly on the nurse bees. Obviously under such conditions the swarming instinct cannot sharpen. The colony will go on growing.

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The expansion of the growing colony will encourage the work of the queen, brood caring, nest building and honey harvesting. This technique is frequently applied to colonies which have already started swarming (there are eggs in the queen cells).

Switching a colony prepared for swarming into an active state can be considerably assisted by bees having arrived from an unswarming colony. Among the latter there will undoubtedly be some scout bees. Like in their own nest, they will immediately begin dancing here with great zeal. The colony will naturally respond to these dances. And the more bees there are dancing on the combs, the sooner all their reserves will be mobilized for honey harvesting.

Bringing in fresh honey and being very active, these bees will automatically attract those which were prepared to leave the hive with the swarm and were not engaged in any work. And thus, in less than one day, the swarming colony regains its working ability.

In the same way, also eager to work are the bees which have flown into the hive together with the unswarming colony. In the nest of the unswarming colony, the amount of work to do has remained unchanged, even though the colony lost its flying reserves. The nest is rich in unsealed brood, fresh brood, and perhaps even combs with honey to be capped. Feeling the mood of the active house unswarming bees, those preparing to swarm get involuntarily infected with their enthusiasm. Furthermore, the colony is still governed by the growth instinct and that of food accumulation is rather strong.

Swarming can be suppressed. When the progressive technology of bee tending, which has anti-swarming as its very base, is not effected properly, particularly when the operations are delayed and the anti-swarm nuclei are formed not from all colonies, swarming then becomes a possibility.

There are some colonies which are more likely to swarm. They may enter the state of swarming before attaining their complete strength. Then they cannot be controlled by the standard techniques for preventing the appearance of the swarming instinct and its intensification.

In such cases, the beekeeper has to suppress this instinct artificially as a last resort. To do so, one has to withdraw from the swarming colony the entire brood or some part of it, as well as some or all of the old bees. In this way the queen is isolated from the nest with brood and provided with room for egg-laying, and the young queen which has only recently started egg-laying is given in stead. These methods take lots of time and labour, but permit the colony to return to its normal working state.

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An uncapped brood instead of a sealed one. In a nest of bees which have prepared for swarming, the majority of combs are already occupied with brood, chiefly capped and mature. The uncapped brood is scarce, only on two or three frames, but in very small quantities. The sealed brood acts as heat generator, it independently creates a nest temperature of up to 36 °C. In addition, this brood constantly supplies great numbers of young bees to replace the army of those which have ceased doing anything in the nest and are ready to leave it.

To remove all frames containing the sealed brood means to eliminate the source of stuffiness in the nest and stop further growth of young bees which cannot turn into nurse ones because of the shortage of uncapped brood. All swarm queen cells are broken up. The sealed brood is replaced by the same quantity of frames with unsealed brood, mainly with young larvae.

The frames with sealed brood withdrawn from the nest are now transferred into nuclei to replace the frames with uncapped brood which were removed from them. They are also used to organize a temporary nucleus to be placed next to the swarming colony's nest.

In a day or two, after the colony begins rearing the brood, it is provided with two frames containing foundation. These frames are arranged in the middle of the nest where the colony will immediately start its building jobs. Now, it passes from its passive state into an active one. The queen is again surrounded by a retinue; the bees increase their flying.

With its sealed brood removed from the nest, its queen cells destroyed, its duties in brood-rearing and comb construction increasing, the colony finds itself in such a position that it has neither effort nor time to spare for swarming. It must mobilize all of its reserves for restoring the integrity of its nest and replenishing the stores of honey and beebread which were diminished when the frames with mature brood were withdrawn.

In preparation for swarming, during the last 10 to 12 days before it starts, the colony steadily decreases the amount of brood it is rearing (the colony may become weak during the main honey flow and will be unable to use it completely).

To make the colony work at full might throughout the entire period of the main honey harvesting, it is joined with its own temporary nucleus before the harvest if it is intense, or at its beginning, if it is long. The nucleus is put on a sheet of paper above or at the side of the nest, depending on the hive design. The old queen is not looked for.

When bees are kept in a multiple-storey hive, the uncapped brood replacing the sealed one is concentrated in the lower storey. Here,

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near the big flight entrance, the bees have more oxygen, and above it, in the middle storey, there are vacant combs for the queen.

The queen is isolated from the brood. It was discovered that the instinct of swarming can die out if the entire brooding part of the nest is isolated from the queen who is not allowed to reach it. This technique was devised by the American beekeeper Demaree, who applied it to his multiple-extension hive.

The hive with the swarming colony is put aside. On its support, one installs a reserve bottom with a storey filled with foundation and empty combs free from the brood. The queen in the swarming colony is found, and together with the bees and combs brought into the central part of the prepared storey. The latter is covered with a screen board. The second reserve storey is placed on top of the screen board, into which the frames from the upper storey of the first hive are now introduced. All swarm queen cells are broken off. The storey freed from the frames is now installed as the third one. The beekeeper continues to transfer the remaining frames and to break off the swarm queen cells.

As a result, the space in the hive increases by one storey, the nest becomes rearranged and unnatural: the storey with the honey, which was previously upstairs, is now second from the bottom (above the screen board), while the two lower storeys with the brood are now on the top. The colony cannot adjust to this unusual state of its nest.

It is a natural tendency for bees to store honey above the brood, which now happens to be under it. As a rule, the queen works on combs in the top or in the middle of the nest, in the part which is more habitable and warmer, while now, in its lower part, the queen has to work under crowded and inconvenient conditions. All this adds to the excitement of the bees hating the new surroundings provided for them, and that is why the colony will immediately mobilize all its reserves for rearranging their nest to its previous state. Now, to please their queen, the bees build new combs on the foundation, carrying the honey from the storey above the screen board which separated the queen from the brood upstairs where she naturally belongs. But as long as the queen remains isolated in the lower part of the nest, there will be a gap between the central part of the brooding nest and its lower part, wherefrom the honey was transferred upward. This gap will keep the colony in its agitated state until the brood in the upper storeys turn into bees.

The isolation of the queen from the brood scatters the bees all over the hive. It compels them to start comb-building so that their nest will again resume its natural order. These duties will naturally dampen the

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colony's swarming instinct. This anti-swarming technique is even more effective because the bees preparing for swarming cannot tolerate a zone in a brooding nest that is free of brood and of food since it is isolated by the frames with foundation. The queen begins to work in the lower storey. Then, to let the drones from the upper storeys, the flight entrance is opened in the storey above the screen board.

In the section most distant from the queen, the bees occasionally feel like making a colony of their own. This desire will become stronger if the flight entrance in this part of the nest remains open. To quench this desire for isolation and to prevent a second colony from forming in the same dwelling, the flight entrances in the upper storeys are kept closed after the drones leave them. But if the bees continue to build new queen cells, the latter must be removed as soon as they are sealed.

It should be noted that in a multiple-storey hive, even a considerable isolation of the queen from the parent colony does not disturb the colony's life and work very much, because in such a hive the bees are in constant touch with the queen. In the first days of honey harvesting, the screen board is withdrawn. This screen board makes it difficult for the bees to pass, particularly with their honey sacs full of nectar. Furthermore, now the queen might need new vacant combs for her egg-laying.

In practice, this technique is frequently used in a partially modified form. Not to waste time searching for the queen (it is not so easy to find her, because the colony at this time is very strong), all bees are brushed off onto the plankboard in front of the flight entrance of the prepared storey. This disturbance takes the bees by surprise. As a matter of fact, the swarm, already formed and quietly awaiting a signal for departure, suddenly finds itself destroyed, mixed up with other groups of bees, and above all, beyond its own nest.

When brushed off, some bees make their way to the flight entrance and even block it, preventing others, which are also eager to get in, from reaching the nest. Many bees speed up into the air to inspect the hive from all sides at some distance away. There are groups and individual bees which stop moving and excitedly flap their wings, as if waiting for their turn to come in and begging the others to let them enter. The bees are under the impression that they are near the entrance of a new home which they have found as a result of swarming.

But on entering this new home, they discover an uncozy, inconvenient, unusual nest which in no way looks like the one they had just recently inhabited.

Right before this operation, the colony was a whole unit which was

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on the way to producing a new colony from its own ranks, due to the powerful instinct of swarming. But now the colony has been taken aback and is in complete confusion, it has been broken to pieces. The nervous system of the bees gets excited beyond limits, and they will be able to return to their normal state only after they feel their queen's presence again and begin working to restore their nest. Thus, the instinct of swarming gets destroyed. The colony acquires its working capacity again.

There is another modification of this technique. The queen is found, and moved to the lower storey together with her comb. The lower storey is completed with frames containing foundation, empty combs and one comb with honey and beebread. Then it is covered but not with a screen board. This time a blank ceiling is installed on it. One or two of the most mature and largest queen cells are retained in the nest. The storeys are rotated 180° and placed on the ceiling. If the colony is of low productivity, its queen cell is substituted by a queen or a queen cell from a good colony. To let the bees fly to their queen, the flight entrance in the storey above the ceiling is opened. This flight entrance will serve as the working one for the nucleus; it will be through this flight entrance, too, that the young queen will go for her mating.

The colony, practically deprived of its entire nest, has nothing better to do than to plunge into work, and in the first place, to begin collecting nectar and pollen. The swarming instinct fades. A couple of days later the nest is expanded with another storey, most desirably with stores of honey and beebread, as well as with frames containing foundation. Now that the colony has returned to its growth stage, the foundation will be required to satisfy the young bees engaged in building their nest.

By this time, the queen in the nucleus may have already finished mating and begin egg-laying. Both of the colonies continue their independent lives up to the beginning of the first main honey flow.

This anti-swarming technique, isolating the brood from the queen, may be employed in long hives, too. A screen board separates the hive in two: on one side is the queen and a few frames of foundation, while on the opposite side there are frames with the brood and food. The queen cells are destroyed. The bees will keep entering and leaving the nest through the old flight entrance. This method prevents the departure of the swarm and returns the colony to its normal working condition. However, the separated bees work with less energy, as compared with those near the queen. This can be explained by the fact that in a horizontally divided nest, the bees of the other half of the colony cannot easily contact and communicate with their queen.

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Without the old bees. In practical beekeeping, both in this country and abroad, there is another widespread anti-swarming technique. To suppress the swarming state of the colony, all its old bees are withdrawn. While the flying activity in the colony which is ready for swarming is still strong enough, its hive is put some meters aside and in its stead the beekeeper places another one.

If the swarming colony is in a 12-frame hive, the new one receives four or five frames with foundation which are arranged in front of the flight entrance. On both sides of the frames there are two combs with mature brood, other combs contain honey and beebread. The colony is provided with a queen, or a mature queen cell is placed among the combs with the brood. The flight entrance is reduced in size. During the course of the day, all field bees from the abandoned hive and part of those which are to form the swarm will return to their old place; they will form a new colony. If the cast after swarming is not energetic enough, the nest of the swarming colony is opened and the bees from the end frames are brushed onto the plankboard in front of the flight entrance of the same hive. As a rule, if a colony is preparing for swarming, bees of the future swarm accumulate on these frames. It is not dangerous if the queen is brushed off together with these bees. She will immediately enter the hive, while most of the bees will fly into the sky and return to their old place, but to their new dwelling. To make the cast of the brushed bees as great as possible, it is useful to subdue them slightly with smoke.

Upon the cast after swarming, the instinct for swarming diminishes: the colony is now deprived of the bees forming the swarm. There is nobody now to guard the queen cells; the queen gnaws them out. To help the nurse bees in their normal brood rearing, the nest receives water; it is supplied into one of the end combs in a quantity of 1 to 1.5 glass.

In two or three days, when the cast after swarming is over, the hive is brought to the place where the colony used to live before. The hive is arranged close to the colony formed by the flown-in bees; the flight entrance is set in the direction familiar to the bees. This fact is very important because thus both colonies can be united into one more easily later on.

The swarm colony restores its working ability within three to five days after the remaining young bees reach their adult age.

The bees which have flown into the new hive do not feel happy and cozy in this inconvenient and unusual nest; they eagerly accept a queen or a queen cell, and by and by begin constructing their home anew.

After the young queen starts her egg-laying (it frequently coincides

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with the onset of the main honey flow or with its eve), the former swarming colony and the young one are united. Such a united colony is rightfully regarded as honey-rich. If the old queen is of value, she is found and taken care of in the nucleus; if she is not useful, she is left in the hive to be destroyed by the bees or by the young queen.

In a honey-rich colony, which is now happy with a young queen, no instinct of swarming is possible. Colonies with queens of this year do not swarm, as a rule, even if the weather and honey-collection conditions are favourable for it.

A swarming condition, having risen in the colony long before the main honey flow (say, 30 to 35 days earlier) is quenched in the same way, but the new colony is provided with a fertile queen instead of a queen cell or an infertile queen.

The former swarming colony and the young one will grow throughout this period. They will manage to rear additionally a great many new bees and much brood; each of the colonies will participate independently in honey harvesting. If they are united when the main honey flow begins, they will form a mighty colony, a real honey-rich one.

This technique of suppressing the swarming instinct by withdrawing the colony's flying bees is also employed in multiple-storey hives. In all other ways it is the same, but differs only in how the nests of the swarming and the young colonies are formed, as well as in the removal of the old bees.

A new colony receives a nest in two storeys: the lower one is supplied with frames containing foundation (on its sides, with one honey- and beebread comb each), the upper one containing sealed brood (ready to leave) and food (without bees and queen cells). If the colony is highly productive, one installs a mature queen cell of the same colony in the middle of the brooding part of the nest, and if it is not, it is provided with a queen or a queen cell of a high-breed colony. The hive with the swarming colony is set aside and replaced by a new one, its storeys prepared beforehand. The storeys with the brood and food are arranged onto the ceiling of the new hive in the previous order. The flight entrance is opened in the storey above the ceiling separating the colonies. Through this flight entrance the flying bees will move into the lower part of the hive to form a new colony there. Before the onset of the main honey flow, both of the colonies will live under the same roof separately, then they are united.

With the energy of a swarm. A colony may happen to have a long period of growth because its queen is highly fertile. And all of a sudden, it will plunge into a swarming mood right before the main honey flow

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or just at its very onset. Under such conditions it may lose its working energy. Then it is driven back into its normal working state by depriving it of the nest and food, in other words, by transferring it into a state of swarming.

In place of the hive containing the swarming colony, the beekeeper puts in a new one with the same number of storeys. The lower storey is completed with empty combs and foundation (four frames in the middle), the upper one – with empty combs. Now the lower part of the nest is unnaturally broken up by the foundation, and an anti-swarming effect is achieved. All bees and the queen are brushed into the lower storey. The frames are returned to their previous place. Only one of the best queen cells is left in the old nest. The bees are not brushed off of this comb, where this queen cell will develop, but are very carefully swept off. As a rule colonies with a long growth period are very valuable, and therefore it is desirable to use their swarm queen cells. The hive with the old nest, overcrowded with brood, is now transferred to the place of some strong unswarming colony. And then the latter, in turn, is placed close to the hive with the just transferred swarming bees.

After the hives are reversed in their order, the unswarming bees begin returning to their old place but into an alien nest. Deprived of their nurse bees and the queen, their flying activity is somewhat disturbed for a while. Despite the fact that there is a swarm queen cell in the nest, the colony may feel depressed and motherless and may start building some emergency queen cells. They resume their flight on the next day, but it will still be weak, because some bees will have to take care of the brood. In three or four days, when the bulk of the brood turns into young bees, the functions of the nurse bees will be taken over by the young ones. The old bees, which had been leading the flights but were needed to nurse the offspring, will now be able to return to their old duties. The flight gains force with every new day, and the colony begins working as hard and gathering as much honey as it used to in its old hive. Emergency cells of queens, if built in the nest by the colony, may remain there intact. They will be gnawed out by the queen when she leaves her swarm queen cell.

When the honey flow is short and intense, but the beekeeper finds it difficult to mobilize all his bees for proper honey harvesting, he joins the unswarming colony together with its nest to the swarming one after the latter begins its honey collection. If the queen in the unswarming colony is still young, she is regarded to be the best in terms of heredity and the beekeeper uses her as the queen for both colonies. When so united, the colonies will have their flying reserves doubled and will increase every day, because more and more of the young bees

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will get involved in the honey gathering, while the brood-tending ones will reduce in numbers (there is only one queen in the colony now). The might of the colony will grow and grow.

If the honey flow is strong and long, moreover, if there are a few of them, the former swarming and the unswarming colonies will use the first honey harvest independently. However, before the second flow they are usually united. Both colonies grow weaker during the first honey harvest, they lose plenty of flying bees and therefore cannot utilize all of the honey available to the fullest. When united, the colony will again acquire large reserves to work and live.

To unite the colonies dwelling in 12-frame hives, the beekeeper installs secondary storeys or two magazines on their top. In multiple-storey hives, the extensions with the brood are arranged downstairs, and those with empty combs for honey and food are set above them.

This technique is labour-consuming, but it enables one to quench the colony's swarming excitement within a very brief time, and, besides, to yield much more honey from this colony than from any other swarming one.

And so, *swarming is biologically justified and caused by one of the strongest instincts in the bees, that of reproduction. Somehow, it is not profitable for beekeepers. Among the numerous techniques prolonging the colonies' growth and precluding their swarming, the most effective one is to provide anti-swarming nuclei (artificial swarms). This technique alone may replace all other means and ways to control swarming.*

The Apiary Grows

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either a commercial bee farm, nor any amateur apiary can do well without the annual appearance of new colonies. Some people need new colonies to expand the size of their apiaries, others want them to replace their old or sick colonies of low productivity. Such rejection helps to get rid of unprofitable colonies of no biological value which appear almost annually even in first-class apiaries. In this way, it is possible to improve the productivity of all colonies and of the entire apiary.

New colonies may be wanted to replenish and restore the losses suffered during winter. They may also be raised for sale.

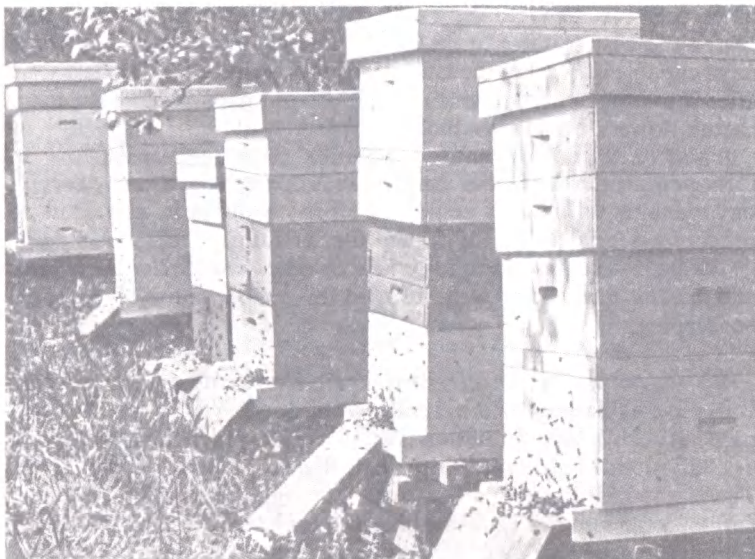
By its very nature, each colony potentially can and must reproduce others like itself. This biological law is used as the basis for creating new colonies artificially.

The timing for forming new colonies depends on the onset of productive honey flows and the ways they are used. The best technique is that which permits the young colony to prepare the required number of workers for the main honey flow and those after it, which will be able to procure for the colony forage for the entire winter and spring periods, as well as to get ready for the coming winter.

Practice shows that a young colony may become strong and productive if it is organized at least six weeks before the onset of the main honey flow. During this time, even if provided with an infertile queen, the colony will be able to feed a large brood. It will be strong enough to meet the onset of the main honey flow, and by the time of subsequent honey flows it will be able to use them as the main colonies do.

In forming new colonies, such techniques are used which do not essentially weaken the parent colonies and preserve their economic value. As L. Langstroth, the father of American beekeeping, wrote, no matter which method of artificial swarming one employs, the power of the old colony should never be diminished, so that its

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An amateur apiary in the garden.

queen's productivity is reduced. He held that this principle must be a law firmly obeyed by all beekeepers.

Any division of strong colonies, if it is made untimely or without proper skill, may destroy all hopes for good honey collection, because even though the number of bees will, indeed, increase, many of them will be poorly prepared for wintering as the end of the season approaches.

The best time to form new colonies is when the maternal (parent) ones have reached their biological maturity and their congenital desire for swarming has already awakened and become strong.

If a colony spent its winter well and its spring growth was not disturbed or retarded by anything, it will reach its biological maturity (the ability to divide) long before the onset of the main honey flow. During the main honey flow, both the maternal colony and the new ones (swarms) will be able to provide stores of forage for their further existence. Had nature permitted a reverse situation, i. e. the appearance of swarms after the honey flow, all young colonies would inevitably have died from starvation, because they would have been deprived of any ability to procure their forage. Then the very existence of honeybees as a species would be threatened.

Nature has been working to improve the races and populations of

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honeybees for many millennia. It patiently selected, rejected and sorted the best of their forms, so that finally it could choose those most capable of rearing the largest of brood within the shortest time after wintering and of producing their offspring long before the main nectar flowers burst into bloom.

Based on this law of natural evolution, man has learned how to form new artificial colonies at such times during which each new colony manages to build its nest and properly grow in it, as well as to procure essential stores of forage for its future needs.

There are several ways to form new colonies artificially; these ways and means have been well justified by many years of practical beekeeping.

The colony is divided into two. Is it possible to create a nucleus which could live as heartily as a natural swarm does? Yes, it is. The technique of such colony formation is known in the practice of beekeeping as “division of colonies into half-flights”, “into halves”, etc. The method for forming a new nuclei, though it may go by different names, is the same. A 12-frame hive or a long one containing a strong colony is placed half a meter away from its old place; an empty hive, if possible of the same shape and colour, is installed at the same distance but to the opposite side. The support on which the old hive stood is removed. Thus, an empty space appears in the area of the old flight entrance.

The colony and the nest (the brood and the combs) are divided into two equal parts; half of them is retained in the old hive, while the other, together with the bees, is put into the nearby hive. There is no need to look for the queen because it is of no practical importance which of the two hives she winds up. The nests of both colonies are restricted by inserted boards, then they are warmed up and the hives are capped with roofs.

This technique is more easily applied to a colony living in a multiple-storey hive, since in such cases one transfers to a new place not just some frames of brood but a whole storey along with its brood.

On their return from the flight, the bees instinctively follow the direction toward their flight entrance which they were used to and from which they had just left when flying to the field. But having come back, they fail to find their home in its usual place.

Being at a loss and greatly confused for some time, they fly above the place, circling the space between the two hives. By and by, the bees begin to distribute themselves: some enter their old hive, and others move towards the one next to it. When flying home, the bees followed some very definite route, but then, as if meeting a strange obstacle,

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they begin splitting into two parts (due to this, the technique is called “colony-division into halves”).

As a rule, the larger part of the bees enters the hive with the queen. They seem to be oriented by a kind of sound signal issued by the bees already in the hive. In view of this, the hive is gradually moved further away till the moment when the returning bees are apparently distributed between the two hives in approximately equal quantities.

In the hive without the queen, the bees get excited and alarmed some 20 to 30 minutes after their arrival. They cover the front wall of the hive and the flight board, their groups fussing about and nervous as if showing their motherlessness. It is this colony that will be provided with a fertile queen.

Nuclei, created in this way, receive bees of different ages, and thus they can function well immediately after the division, working properly in the field (they can collect nectar and pollen, bring water), taking care of the brood, building their combs. Such nuclei are of high biological value.

Colonies are divided at the time when they become sufficiently strong and show signs of their readiness to swarm (when they begin building their queen-cell cups), their flying activities still intense. Both of the new colonies will have enough time to gain strength and supply themselves with forage stores for winter. And if the first main honey flow is followed by a second one, and then by a third, both of the new colonies will yield their keeper some good commercial products.

Nuclei, provided with virgin queens or queen cells, will grow more slowly than those with fertile queens; they will store less forage, but by winter they will have developed normally into good colonies and will be quite able to procure sufficient quantities of food.

Colonies which can be divided at an earlier time (colonies reach their biological maturity at different times) will result in new colonies of better quality. By the onset of the main honey flows they will be able to rear large reserves of foragers, particularly if upon their organization such new colonies are provided with one or two frames of mature brood from undivided and healthy colonies.

When there is any infection or disease in the apiary, no reinforcing of new colonies with brood or bees from other colonies is ever permissible, and all techniques requiring such ways and means should be avoided in practical beekeeping.

To divide colonies into halves at the beginning of the main honey flow, or to compel the queenless half of the colony to raise emergency queens (unfortunately, such recommendations may be encountered nowadays!), does not prove to be economically profitable. In colonies which obtain fertile queens upon the colony-division, the instinct for

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growing increases. Their queens begin laying eggs very quickly and the brood-tending jobs increase. As a result, the flying reserves of such colonies, which are rather scarce, generally decrease. Under these circumstances, the bees will be unable to store much honey from the first main flow; they will only be capable of procuring forage from subsequent honey flows, if they occur.

The flying energy for gathering honey is much weaker in colonies rearing emergency queens than in colonies with fertile queens. By the time the queens get strong and mate, the colony's flying activities will stabilize, but the honey flow will already be over or approaching its end. Besides, such colonies tend to grow weaker. More than 40 days will pass between the appearance of emergency queens and the birth of new bees. This period is equal in length to a bee's life span. And it will take the colony still more time to accumulate its flying reserves which are so badly needed. The nearest honey collection may again be fruitless for such colonies. In the end, the beekeeper will have to feed his bees with ready honey or sugar, in other words, to keep bees that can only consume but not produce. It is quite possible for these colonies to remain unproductive even during the next year, because their queens are only emergency ones.

It is equally unprofitable to divide colonies after the main honey flow, since the commercial honey collected by a strong undivided colony must be fed to the new nucleus. It frequently happens that nuclei which are formed late fail to raise sufficient numbers of bee reserves and have to enter the winter considerably weak.

A nucleus made of bees and brood from several colonies. It is sometimes more profitable to organize a new colony not from one but from two or three colonies, so as to make it stronger. This new colony is provided with a fertile queen. Such a nucleus is traditionally called a collective one. The method of its formation is the same as for an anti-swarm nucleus (individual one).

Collective nuclei have one significant drawback: only young (unflying) bees remain there. They are not yet familiar with the locality and therefore do not return to their maternal nests. This biological peculiarity of young bees is the basis of the method of artificial swarming in which some part of the colony's bees and brood are separated from the rest to initiate a new colony. Young bees are yet unskilled in performing most of the jobs in the hive, and even more so, in the field. Therefore, within the first four to five days the nucleus does not show any signs of life (the bees do not leave the hive at all).

The picture is quite different in a natural swarm. It attracts and carries away such bees which can perform all jobs, both in the nest and in

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Nucleus hives.

the field, from the very beginning of their independent existence. However, a collective nucleus may also be turned into one of high biological value. Such nuclei are formed not during the day but closer towards evening when the bees have almost ceased their honey-gathering flights. The old bees which get into such nuclei do not return to their maternal nests.

The flight entrances are kept closed during the formation of the



A new story is added to the colony.

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nuclei. The nests are reinforced to be transported. In the evening the colonies are transferred to a new place and source of honey flow which is at least 5 km from the apiary, so that the old bees cannot return to their old nest, otherwise the nuclei becoming biologically inferior. The next morning the bees make their flight around and start their normal working life. During their honey-gathering flight, the flying bees will lose their conditional reflex to return to the old place, and having returned to the apiary, will not fly to their former nests.

In strong collective nuclei, conditions good enough for the queens' egg-laying and for all urgent jobs to be performed are immediately created. In terms of their productivity, such strong nuclei almost do not differ from the maternal colonies from whose reserves they were formed. Furthermore, when a small quantity of bees and mature brood of the maternal colonies is removed, their physiological condition improves: their instinct for swarming is thus prevented from intensifying, the period of growth is extended, they remain very active.

A nucleus after wintering is the basis of a new colony. In modern beekeeping, the main purpose of nuclei having reserve queens is to serve as the basis for forming new colonies in spring.

In the two-queen system of beekeeping, such overwintered nuclei are in much greater demand; depending upon the technology adopted and the nature of the main honey flow, they may constitute at least half of all colonies in the apiary.

In horizontal hives with 435×300 mm frames (long ones), nuclei are most frequently arranged to the side of their maternal colonies; in multiple-storey hives they are traditionally arranged on the top. During the first period after their spring flight of cleanliness, the nuclei grow independently, using the warmth of the neighbouring nests.

It is true that due to their small numbers, the queens in the nuclei work far below their capacities. When the overwintered bees are replaced by new ones and the maternal colonies begin gaining in their live mass, the beekeeper removes from them one or two frames of the mature brood (i. e. those ready to leave) but without bees, so as to strengthen the nuclei. When young bees breed out of these frames, the nuclei are strengthened again. Upon such double reinforcing, they become vital and grow well.

When the removal of brood-containing combs is gradual, it does not weaken the main colonies and will not retard their growth. The queens will lay eggs in the combs, installed in the nest in place of those removed, thus restoring the quantity of brood. On the contrary, partial removal of the sealed brood will benefit the activity of the colonies, preventing any manifestation of the swarming instinct.

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With time, the horizontal hive will become too crowded and small for the colony and the nucleus; it will begin hindering their growth. Then the colonies will be separated. The main one will remain in its hive, the artificial swarm (the former nucleus) is transferred into a new one placed nearby, its flight entrance being in the same direction and at the same level.

In multiple-storey hives, the artificial swarm is not touched. Its nest is enlarged by supplying a new storey as required by the expanding colony.

Such early nuclei turn into stronger colonies than those organized later. By the onset of the main honey flow they are quite capable not only of providing themselves with sufficient forage, but even of yielding considerable amounts of commercial honey.

Many beekeepers prefer to have three or four nuclei with reserve queens in one 12-frame hive which they deadily divide into plywood-walled sections, their flight entrances facing different directions.

When the nuclei gain great strength and the queens need new areas to lay their eggs, the colonies at the extreme sides of the hive will be resettled into other hives arranged on the sides of the old hive with their flight entrances facing the old direction. It is best to arrange the transportation to the new quarters at the same time as the brood is being reinforced. The nests of the nuclei remaining in the old hive are enlarged. When positioned in this way, the little colonies will be able to warm one another still for a long time; that is, they will be able to grow well.

If it is necessary to employ one of the queens for improving a queenless colony, the bees and the nest of the nucleus are joined to the neighbouring one.

If desired, the number of colonies may be increased at the cost of the best anti-swarm nuclei made from the bees and queens of the most productive colonies of the apiary. Swarms may also be used, provided they meet all the requirements.

Colonies of package bees. In setting up new apiaries or expanding old ones, beekeepers use package bees. They can be bought in special bee-nurseries which send their clients package bees through the mail (in special boxes) to be transported by air, railroad or automobile.

The package method of beekeeping permits one to start a new bee colony earlier than one could use the traditional technology of apiculture. Organized in this way and so long before the main honey flow, such a colony is able to take a practical part in all honey flows of the season, and to prepare itself well for the coming winter. In the very first year of their existence in the apiary, the package bees are able to

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build themselves a new nest, to procure good stores of forage. With the conditions of weather and honey-gathering most favourable, they very quickly repay all the expenses incurred by the beekeeper in obtaining them, and they often even bring him some profit.

A package with bees is a peculiar swarm because in reality it is a significant mass of bees (weighing 1.2 kg) with a queen but without a nest. When en route, the bees are fed on liquid forage by a special steel feeder. Bees can also be mailed in comb packages, containing the same mass of bees, a fertile queen, four nest combs (of which one and a half combs contain some sealed brood) and 3 kg food.

Comb packages are usually sent to beginners just starting their apiaries. Such packages are transported in dark, ventilated plywood boxes; combless packages are delivered in netted boxes. In such a package the bees have fresh air regularly, they hang inside the package like a swarm on a branch. They feel quiet and can tolerate their long way fairly well (for 2 or 3 days they can even go without food).

A netted package is much smaller than a plywood one; this is very important when mailing bees over long distances, especially by plane.

In world practice, bee-nurseries send bees only in a combless package. Today, neither the sophisticated commercial nor the amateur beekeeper can do well without this package type of apiculture.

Production of package bees is characteristic of special farms in Moldavia, the Ukraine, North Caucasus, Georgia, Central Asia. In these areas, nature awakens from its slumber very early, supplying bees with nectar and pollen when in other parts of the country the weather is still cold and even with temperatures below freezing. Bee colonies in these areas rear abundant brood. By the time the bees in the central territories of Russia, in the North and Siberia have accomplished their first spring orientation flight after their wintering, the bee-nurseries and bee farms in the south of this country will have already been able to make a package of bees from each of their colonies. In Turkmenia, for example, the local young bees replace the wintering bees as early as in March. The beekeepers here may start sending bee-packages as early as late April or early May. By this time the local bee colonies are usually strong and ready for swarming. To remove some of the bees is not only harmless now but even beneficial: the swarming instinct diminishes and the bees again begin to grow. By the time the spring nectar plants burst into bloom, such bee colonies are well prepared for honey collecting since their numbers increase considerably. They can make good use of the nectar plants, yielding much honey during the first honey flow and increasing their harvest during the following ones. Such bee colonies may provide sufficient numbers of bees even for a second package.

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Packages are made of young bees still incapable of flying. They will have to build their nest in a new place, to bring up new generations of bees for the main honey flow, to rear a lot of brood from which the colonies will recruit their reserves, making them stronger. A package composed of bees which have already taken part in honey collection, will not be capable of fulfilling these biological functions.

It is vitally important for the package mass of bees to satisfy the requirements exactly. A colony weighing exactly 1200 g is found to be quite capable of independent growth. It can prepare well for the main honey flow and provide itself with forage stores for winter.

The normal growth of a package colony is directly proportional to the queen's capacity to lay eggs. It is well known that the highest egg-laying capacity is observed in young queens under one year of age. It is such queens that are usually attached to package bees. As a rule, the queens for such packages are taken from queen-rearing apiaries, while the bees—from commercial ones. At first, the queen is placed inside a special cell (cage) at the top of the package, beneath its ceiling. When a comb package is made from one (maternal) colony, the queen is not inserted into a cage, she is kept together with all the other bees.

A package colony should be able to use the main honey flow already in the current year. In view of this, it is necessary to see that it reaches its destination at least eight weeks before the beginning of the honey harvest. Requests for bee-packages are usually made considering this time-limit. It goes without saying that colonies having a longer time to prepare for honey harvesting will be more productive.

When one wants to expand his apiary, packages which arrive later, but never after the onset of the main honey flow, can be used as long as the bees have at least enough time to procure forage for winter.

Before the package bees arrive to their destination, the beekeeper prepares a hive with a complete set of empty combs and foundation for each package. If these combs contain honey and beebread, which is highly desirable, the hive is covered with a roof and ceiling, the flight entrances are closed, so that robber bees, ants or wasps cannot penetrate it. In the case of comb packages, the hive to receive them is supplied with a comb containing honey and beebread; combless packages are usually provided with four or five frames loaded with forage.

As soon as packages with bees arrive to a railroad station or an airport, they are carefully kept in the shade or in some cool place with free access to fresh air. By the end of the day the packages are taken to the hives and the bees are resettled there. By this late hour of the day the air temperature cools down, the flight of bees from other apiaries ceases, and there is no danger of any attack against the packages. Package bees will not venture to start their orientation flight at such a

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late hour either. During the night they will calm down and get to know their nest. If the weather is gloomy and cool, the package bees can be moved to their new hive during the day time, too.

The frames with bees, one by one, are placed from the comb packages into the hive; if there is a cell with a queen, it is installed in the middle street. Then the bees, still remaining on the walls of the box, are shaken out upon the combs.

A combless package is placed close to the hive, opened, and its bees are shaken off into the hive; the cell with the queen is placed between the frames. The box with the rest of the bees is inserted into the hive. The nest is closed. To keep the warmth within the hive and to prevent any intrusion of robber bees, the bush of the flight entrance is fixed at the small notch and the upper bee gate is thoroughly closed.

If the number of combless packages is small, it is possible not to shake the bees out but to employ the following technique. The hives are prepared beforehand and each one of them is provided with an empty storey. Combless packages are arranged onto the frames above the cells with the queens, the packages having their open side up. Then the hives are tightly covered up. The bees will gradually move onto the combs by themselves. It will take them an hour or two, after that the empty mail boxes and the storeys are removed. During the night the package bees will get to know their new nest, in the morning they will conduct their orientation flight and start working in the field. Upon their orientation flight, the queens are released from their cells.

In case the queen in the package perished in transit, the package bees are distributed among two or three colonies.

When a new apiary is set up and there are no combs ready, the combless packages are placed onto foundation frames and the bees are immediately supplied with food. Feeders with sugar syrup are placed either at the side or on the top of the nest. More syrup is added as the feeders empty. Package bees resettled onto prepared nests also have their feeders replenished. To help a package colony develop normally and become productive, it must receive at least 10 kg of food in the first two or three weeks. It is also desirable that such bees enjoy at least a small honey flow which keeps them active.

If the bee-packages arrive by the onset of productive honey flow and the weather conditions favour the bees' work, it is not necessary to supply them abundantly with food.

When a colony has started its active work, it is not disturbed for about two weeks. But colonies which do not fly much and do not collect any pollen pellet should be inspected within five days after their resettlement in the hive. Queens that have not yet started egg-laying are destroyed and the bees are joined to neighbouring colonies.

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During the first two weeks, the larger part of the frames are occupied by the brood, the number of bees in the colonies starts decreasing. By the end of the third week the quantity of bees becomes much smaller than the brood-tending requires. But this critical period does not last long. As soon as young bees are hatched, the colony speedily regains power and its growth quickly recovers. Nevertheless, it is better to be on the safe side and to reinforce each colony with one or two frames of mature (ready to leave) brood or with some queenless combless package of bees before this critical time begins. Bee-breeding farms specially provide such packages of 400 to 800 g of bees in each. Bee-packaging is particularly popular in foreign countries.

Reinforced colony-packages grow rapidly. Four weeks after resettlement the hives are enlarged in volume: new storeys are installed beneath the old ones, the freshly inserted storeys contain frames with foundation and empty combs. Some seven to ten days later, when the colonies have properly settled down in the new storeys, the latter are reversed with the old ones.

By the time the plants responsible for the main honey flow begin to bloom, each package colony will have occupied both storeys and will have at least 10 frames with brood; in other words, it will be very capable of collecting a lot of honey.

Package colonies with young fertile queens never enter the state of swarming. They are easy to take care of and do not require a great deal of work. Consequently, with the same expenditure of time, one can handle an apiary which is two or three times as large as one with overwintered bees.

Bee-nurseries send their bee-packages to increase colonies in different apiaries only according to a strict plan, with regard for local zonation and breed distribution.

Thus, the central regions of Russia, Siberia, the North and the Far East receive only Middle-Russian bees. Amateur beekeepers can get bee-packages by sending their orders to apiculturists' societies.

Man-Bred Queens Are Similar to a Natural Swarm Queen



chievements in practical beekeeping depend upon a number of interrelated factors. The most important is the quality of the queen, namely, her high fertility and inherited properties. "Being the mother of all members of the colony," wrote G. A. Kozhevnikov, "due to the laws of inheritance the queen passes on to her family the inherited properties embodied in a latent state in her eggs."

Queens differ in their fertility. The queens of the Italian Golden breed are thought to be most fertile. The fertility in the Middle-Russian forest queens is also rather high. As a rule, colonies with queens of the Middle-Russian breed can rear large masses of bees and heavy bulks of sealed brood. This is true not only in areas where the nectar plants, responsible for the main honey flow, burst into bloom some 80 to 90 days after the bees make their first spring flight of cleanliness, but also in regions where this period is twice as short, say, in Siberia, the Urals, in the north of the USSR.

Queens of low fertility usually cannot lay more than 1500 eggs per day. Such queens can hardly provide colonies of high economic value; they can become profitable only toward the late main honey flow (on the buckwheat or sunflower).

Naturally dwelling bees usually have queens of high fertility. In their long struggle for life, the right to exist was won only by such bee breeds and populations which under the given actual natural and climatic conditions were strong enough to preserve themselves and maintain the continuation of their species.

Over the course of natural selection and evolution, those colonies with highly fertile queens survived, and those with queens of low fecundity perished. Being too few in numbers, they were incapable of providing themselves with sufficient amounts of forage, neither could they withstand the severe effects of the environment.

Queens' fertility depends not only on the properties inherited from their parents, but also on the conditions they were reared in, on the

Man-Bred Queens and Natural Swarm Ones

might of their colony, its physiological state, on the stores of forage the colony enjoyed.

The colony breeds swarm queens. In their attempts to adapt to environmental conditions, bees have historically developed the ability to determine the time most suitable for breeding their queens. As a rule, this time arrives when the weather becomes stable and warm, and nature begins to supply the bees generously with forage so that their colony reaches such a stage in its growth that makes it capable of swarming. The colony's nest is full of brood of different ages, honey and beebread are abundant. Under these favourable conditions, bees can rear queens with the highest possible qualities: they are well built physically, their weight is the heaviest, the number of their ovarian tubules is the largest and their size is the greatest. Such queens are called swarm queens since at this time colonies are governed by the instinct of swarming.

Getting ready for swarming, the bees build their wax queen-cell cups which, in fact, are the rudiments of future queen's cells; they are shaped like the cap of an acorn. The cup is eight to nine millimeters in diameter. Bees usually construct them on the edges of honeycombs, on their bottoms and in places the combs are disturbed. Before the queen lays her eggs in the cups, the bees slightly expand their walls and narrow them to the size of a working bee's cell. This is done to encourage the queen to lay only the eggs which are already fertilized (if the diameter of the cup is larger than that of the bee cell, the queen will lay there only unfertilized eggs which produce drones).

For about three days the embryo develops inside the egg. By the end of the third day, due to the heavy weight of the fetus, the egg assumes an almost horizontal position in relation to the cup bottom. At this time the bees put into the queen cell a little drop of royal jelly. It softens the egg shell and thus facilitates the appearance of the larva. But the most vital purpose of this drop of royal jelly is to supply the larva with a sufficient quantity of food from the very first moments of its post-embrionic development.

As a rule, the weight of such food exceeds that of the newly born larva by more than four times. Now the bees expand the opening in the queen cell, which they had carefully narrowed before, till it reaches its former size. This is necessary for the normal physical development of the queen.

A colony preparing for swarming has no greater concern than to rear good queens for its future offspring. Therefore, the bees take particular care of each and every queen's larva. Since the very first seconds of its existence to the very last moment of its life, the larva

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regularly receives the same abundant quantity of royal jelly.

This royal jelly is poured by the bees right into the queen cell.

Swimming in the jelly, the larva eagerly eats and swallows it; it makes some circular movements and grows very fast, however the amount of its food is not decreased but, on the contrary, steadily increased, as the bees bring more and more jelly. As the larva grows, the bees respectively build up the walls of the queen cell. During the last 24 hours before the bees seal the queen cell, they visit it more and more frequently, occasionally up to 3500 times a day. In five and a half days the bees will seal the queen cell with a porous air-proof cap.

It has been discovered that the queen larva goes on consuming much food and growing for about 12 hours after the queen cell is sealed. The larva turns into a pupa. Some 16 to 17 days after the queen lays egg, it breaks up the cap of its cell and leaves it.

As a rule, swarm queens are born strong and heavy (200 to 220 mg), their sexual system being very well developed. Their ovarian tubules reach the maximum number of 400, each having as many chambers as possible, namely 13 or even more. With the average quantity of tubules equal to 300-350, 3900-4550 eggs can simultaneously mature in the queen's ovaries.

The fertility and working capacity of the queen depends on her weight and the maturity of her sexual organs. The greater the number of her ovarian tubules is and the longer they are, the more fertile is the queen.

Swarm queens reveal their morphological peculiarities more evidently. They pass their inherited features on to their offspring much more completely. But the queen also bears some inheritance from drones, too. Thus, a fertile queen determines the quality of the whole colony, its power, working capacity and viability. If the queen belongs to a good genetic line and has inherited such valuable features as high productivity, a weak swarming instinct, a peaceful character, winter hardiness, then her offspring will be also of great value. And vice versa, if the queen is of a low genetic quality. In view of this, it is very important that each colony have a queen of the highest possible class.

It is feasible to use swarm queens, reared by a colony with good inherited features, as replacements for old queens. To raise valuable swarm queens at an earlier time, a colony of high breed is artificially excited into a swarming state.

There are special techniques to rear queens which will be equal to swarm ones in all ways.

Artificial rearing of top-class queens involves several important operations. First, the beekeeper has to choose carefully a maternal colony and thoroughly prepare drone-rearing ones. The larvae should all be of the same age and then they are introduced into the queen's



A queen-rearing apiary.

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frame which is inserted in the nest of the rearing colony. The beekeeper sees how the larvae are accepted there and then cuts the mature queen cells out to distribute them among the other colonies and nuclei.

Progenitor colonies are evaluated in terms of their offspring. In the same apiary, the colonies usually differ in their commercial qualities, and particularly in their inherited features. Some inherit from their ancestors their high winter hardiness and only very few of them die from cold. They are full of working energy in spring. Their young bees replace the overwintered ones without any adverse effects on the colonies which grow fast and well, reaching their maximum weight and expanding their capacity for productive honey harvests from spring to autumn. Other bees emerge from wintering badly weakened, losing heavy numbers of their ranks due to cold. They grow slowly in spring and fail to gather much honey, though the conditions they lived in were quite similar to those faced by the bees in the first group. There are colonies of high winter hardiness, capable of gaining great strength in spring, but revealing an extremely strong swarming ability, because of which they do not use the honey flow to its utmost.

Such discrepancies in heredity can be noticed primarily in apiaries whose beekeepers do not pay proper attention to the problems of breeding. They expand the number of their colonies chiefly via new swarms or nuclei, and do not take into consideration the top-breeding properties of their maternal colonies.

Frequently, poor colonies can be encountered in apiaries where the maternal colonies which supply the breeding larvae are not selected properly and the reared queens are mated with drones from colonies of low productivity. What are the most frequent mistakes made by beekeepers in selecting their maternal colonies?

The breeding merits of a colony can best be judged by the results of the colony's work during one season. However, the results of only one year may not always be reliable. There are cases when a colony of inherited low productivity suddenly proves most productive, because in spring it might have received bees which joined them from other colonies. Having become much stronger, it began to grow much faster than the others and by the onset of the honey flow it turned into a very mighty colony. It is also possible that during its swarming this colony was attacked by a big swarm. But the beekeeper may not notice either the spring arrival of bees from other apiaries, or the addition of a swarm, and therefore assessing the productivity of this colony he mistakenly includes the colony in the breeding nucleus of his apiary.

There can be other circumstances when a colony of poor breed-

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ing qualities may be wrongly regarded as one of high productivity. For example, a colony might be enjoying its life in a good and spacious hive; or its nest might be composed of top-quality combs; or it could receive more beebread and honey than the other colonies. And, finally, its queen might be younger than those in the other colonies.

If we take any of the colonies which were unjustly assessed as highly productive, and rear their queens to introduce them later into colonies along with the discarded ones, we shall see that in the next year these colonies, having received new queens, will prove to be of low productivity anyway.

To determine reliably which colony in the bee-yard is the best in terms of its inherited features, one should take into account its productivity not for one, but for two years. It is also necessary to consider how the colonies withstand the winter conditions, how they grow in spring, and also their ability for swarming.

If your conclusion on the high breeding properties of a colony is correct, it will prove to be right the very next year also whatever the weather or honey-collecting conditions may be.

In assessing the breeding properties of any colony, it is of special importance to consider the results of the year not only for the progenitor (maternal) colony but also for those colonies which have its queen-daughters. If, provided all other conditions are equal, they yield as much honey or even more, then the maternal colony is beyond a doubt of high breed and should be used to provide the larvae for rearing queens.

It is highly essential that the progenitor colony should be thoroughlybred. All of its individuals must reveal distinct features and characteristics typical of a strictly definite breed of bees.

Colonies with bees whose body colour is heterogeneous are never pure blooded. They will be of no use for breeding purposes, irrespective of their high commercial qualities. The latter will not be passed on to their offspring.

Based on these features, the beekeeper's selection of bees for his apiary will permit him to set up a good breeding nucleus to be used in the future for raising colonies of high quality. Later on, this group of high-breed colonies may be renewed or replenished by adding highly productive colonies of record-breaking stock.

Thanks to such breeding nucleus, one can periodically substitute new colonies for the progenitor ones, and thus prevent inbreeding. The highly productive colonies will grow in number in the commercial group, while the quantity of ones of low productivity will decrease.

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The inheritance of the colony is determined by drones, too. The hereditary background in the colony depends not only on the properties of the mother but also on those of the father.

As long as they remain in the ovaries of the queen, all eggs are alike. Each one of them bears the same intricate set of genes and their combinations which determine the development of all three members of the colony, namely, the worker bee, the queen and the drone. During egg-laying, some eggs get fertilized with the sperm and enriched with the genes of the male sexual cell. Later on they will give birth to female bees. Other eggs remain unfertilized and retain their former maternal basis. These give birth to drones, retaining and passing on to their progeny properties typical of the queen and worker bees of the colony.

When breeding domestic animals, one can obtain highly productive progeny by combining the material grounds of the parents. To do so in beekeeping is almost never possible. Both under natural conditions and in the apiaries, queens and drones mate in the air beyond man's control. This is a unique feature of beekeeping but, at the same time, it is a particularly difficult problem for bee-breeding.

Bee-selectionists face a very serious obstacle in their bee-breeding, namely the fact that the queen meets not one but several partners to mate with. It has been reliably determined that a queen mates not with one drone, as it was believed in the past, but with a dozen or more. From the point of view of purely natural benefits, this is a highly logical thing which prevents any possibility for the species to degenerate, which is inevitable in the coupling of close relatives. But this logical multiact coupling of queen bees turns out to be a very serious hindrance for bee-breeding. It is good if all of the drones mating with the queen are of high breed. It is still better if all of them originate from different genetic lines. Then the colony of such a queen will have a very rich inheritance fund (bank). But if drones from colonies of high swarming ability and of low productivity, or of low resistance to winter mate with a queen, then no matter how great the merits of the queen, all of her best properties will be lost for her progeny, the genetic background (the basis for inheritance) will deteriorate by 50% at least.

Drones from highly productive colonies will pass on to queens their stores of sperm which will later determine to a great extent the most valuable inherited properties in many generations of worker bees.

In large commercial farms rearing bees, the following practice is rather popular for the insemination of queen bees. A special zone is saturated with drones raised in parental colonies of a high breed, or queens are mated with drones in strictly isolated mating stations. Ever

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increasing in this country and abroad is the practice of artificial insemination of queen bees; in this way their offspring are sure to receive the best characteristics and merits of their parents.

Amateur beekeepers should not encourage drone breeding in colonies of impure blood; it should be fostered in specially selected parent colonies. The latter are usually set up by cutting out pieces of combs with sealed drone brood or by using special building frames.

It is already in spring, when the colony is in its growth phase, that its nest is assembled of honeycombs entirely composed of regularly built bee cells. Only a very few elongated or deepened honey cells may be left in the upper quarter of the combs (the bees usually fill them with honey). But when the colony starts its preparation for swarming, the very same nest will not be able to prevent it from rearing drones. If the colony is not provided with some special place to build drone combs, it will by all means reconstruct some of bee cells into drone ones. To preclude such reconstruction, and in this way to prevent the appearance of undesirable drones (of low breed), one installs building frames right in the place where queen bees are reared. A building frame is inserted in the nest of each low-breed colony when the bees begin constructing their drone cells. The frame is retained in the nest throughout the entire period of the bees' active life. Satisfying their need in building their drone cell, the bees start creating a drone comb in the window of the building frame; the queen lays her eggs there. To facilitate the bees' tending to the drone brood, and at the same time to minimize the amount of mites, the pieces of drone combs are removed regularly every nine to 10 days. With its drone comb gone, the colony has to build a new one in its place. The queen will again lay her eggs in it. The comb is again removed, and so on, and so forth, until the onset of the main honey flow. As soon as the colony plunges into honey collection, its desire to rear drones vanishes immediately and the bees will fill the drone comb with honey.

When installing the second storey in a 12-frame hive or the alternating one in a multiple-storey hive, the building frame is elevated to be more easily available. With magazines, the bees are allowed to continue their construction of drone combs in the upper magazine which now has an empty frame attached on one of its sides. The bees are happy to build a drone comb in this frame as well.

In this way, a building frame or an empty semi-frame can prevent the breeding of drones of impure blood and permits the beekeeper to prevent the reconstruction of bee combs into drone ones. Owing to this technique, he does not have to disassemble permanently the entire nest in search of combs with drone brood to be cut out; such a method facilitates varroaosis control and increases the wax yield.

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It is also possible to employ industrially manufactured drone-traps. Such traps are placed near the flight entrances of the hives for a short time, say from two to four o'clock p. m. when the male bees fly out in huge masses. Drone-traps diminish the possibilities of queens' mating with drones of poor or unknown qualities, but they also hinder the work of bees for a while, particularly of those loaded with nectar and pollen.

Drone breeding can also be prevented and restricted by providing the nest with combs containing worker bees' cells, also the old queens are regularly replaced by young ones. If all beekeepers would use this technique, all zones of amateur apiaries would be saturated with high-breed drones.

In bee-breeding there is a very important, but unfortunately almost unused technique of mating young queens with high-breed drones. By this technique, queens are mated before the drones in colonies of impure blood appear. To this end, drone-rearing colonies are artificially excited into a state of swarming earlier than swarming would have occurred naturally. Thus, the colonies are forced to rear their drones at least two weeks before the usual time.

To see that the drone-rearing colony raises greater numbers of drones as early as at the beginning of spring or even in autumn, one or two combs in size of a palm containing sections with drone cells are installed in the middle of the nest. It is better to have these sections in the middle of the frame (at this time the queen is reluctant to lay eggs in a continuous comb of drones).

Rearing a queen which equals a swarm one in her physical power and fertility can only be accomplished using a colony of full maturity that has finished its final growth phase. This colony must completely occupy two storeys in a multiple-storey hive or a whole 12-frame one, so that it will have at its disposal large quantities of brood and especially of beebread. But the most important condition is that its physiological state should be the same as that concurrently existing in colonies rearing their swarm queens. If the beekeeper feels that by the time he needs to rear queens the progenitor colony will not be able to complete its growth naturally, he speeds up that growth artificially: he narrows the nest; warms it up well; reduces the size of the flight entrance to a minimum; and every night for two weeks, he supplies the bees with half a liter of a warm honey drink.

Frequently, sugar syrup is used instead of the honey drink. But it was discovered that if a colony receives sugar syrup, the quality of its royal jelly deteriorates significantly. Such impoverished royal jelly will naturally affect adversely the quality of the queens. It should be mentioned, by the way, that royal jelly obtained from bees fed on

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sugar syrup is not accepted by the pharmaceutical industry. The biological activity and therapeutic properties of this royal jelly are greatly inferior to those of the royal jelly produced by bees fed by natural honey.

A week before the larvae to be raised as queens are inserted in the hive, the colony to rear them is additionally supplied with a honey-pollen mass (prepared from equal quantities of uncrystallized honey and pollen). Before the bees receive it, the mass is diluted with slightly salted water (one half glass of water and 1.5 to 2 g of fine table salt per 200 g mass). It is introduced to empty combs, 200 g per comb, or poured into feeders to be given to the bees every other day.

Such a regime of feeding is recommended until the queen cells are sealed. In recent years, some authors have claimed in their publications that queens reared by colonies without additional food but with large stores of honey and beebread, prove to be in no way worse, but even better than those from colonies which received additional food. They attribute this to the fact that under natural conditions a colony raising swarm queens is geared differently in terms of its physiology, and with every new day the food-searching activity of its bees decreases. At this time the bees seek a bit of peace and quiet rather than any excitement.

When rearing queens, the colony is not loaded with construction jobs either, because bees never build combs when they are preparing for natural swarming.

The queen-rearing colony requires an uncapped brood. No honeybee colony can live without its queen. Therefore, as soon as a colony feels the queen's absence it immediately starts rearing a new one by transforming the organism of a worker bee's larva into that of a queen. If not for this exceptional gift of nature, for this extremely unique biological feature of honeybees, the very species of this social insect might find itself on the verge of extinction because there are many cases of queens' death: a queen, starting her route to mate with drones, faces obstacles and dangers at each step of the way. She can be swallowed by honey buzzards, or caught by other insects which kill bees; a sudden wind or rain may blow her off into a water reservoir where she may freeze and die. Fertile queens perish from diseases and from chemical poisons which may be ingested together with their food; they may die from old age.

This ability of bees to rear themselves a new queen from an egg or a larva of a worker bee forms the basis for artificial queen-breeding.

After a parent colony starts its preparation for swarming (having finished building its queen-cell cups), it is deprived of its queen. It was

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not long ago that some apiarists recommended the removal of both the queen and the entire open brood from the nest simultaneously. It was believed that, deprived of its open brood, the colony would rear greater numbers of larvae to be queens and would feed them better since its nurse bees would no longer be engaged in taking care of the brood.

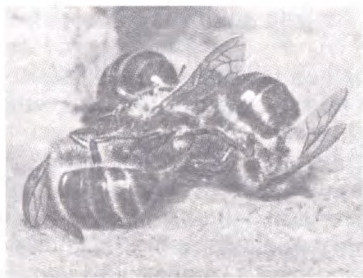
It is true that a queenless colony without open brood does accept greater numbers of larvae. However, as seen from practice, queens reared without young brood prove not to be superior but inferior: their weight is lower, as is the number of their ovarian tubules and chambers. Apparently, when the rearing colony is deprived of its open brood, it is deprived of its main stimulator since the brood stimulates the activity of the bees' maxillary glands. Without such a stimulator, as Academician Ivan Pavlov noted, the endocrine glands gradually diminish their secretion and finally cease their normal functioning. The hopes that the queen-larvae would be taken better care of are not realized. In artificial queen-rearing without open brood, the bees supply queen cells with much less food than in the case of swarm queen cells. It is well known that bees raise swarm queens not only with their open brood intact but even when their queen is at work. In view of all this, today the uncapped (open) brood is no longer removed from the colony rearing queens.

Since the queen withdrawn from a rearing colony is very important, she is placed into a temporary nucleus to be preserved.

The bee-jelly for larvae of bees and of queens is not the same. A colony, deprived of its uncapped brood, shows its excitement over its motherlessness in different ways. A motherless colony makes a loud noise of variegated voices so that it seems that the entire colony is roaring. The colony is also affected by the pheromones of the queen's substance (their effects grow weaker with every minute that the queen is absent). The reaction to this motherless state also depends upon the breed of the bees. Some queenless colonies burst into protest some 20 to 30 minutes after their open brood is withdrawn, others will do it later. It is in this state of despair that the colony starts building its new queen cells, or rather reconstructing some cells with the open brood into emergency queen cells. According to the Research Institute of Apiculture, in the majority of cases, such colonies demonstrate their ultimate despair and actively begin building new queen cells five to six hours after the removal of their queen. And it is this period of time that is now regarded as the best for providing a queenless colony with larvae to be queen-reared.

Being in a great hurry to raise its queen as fast as possible, a queen-

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A battle with an alien bee.



Bees beg to a strange nest.

less colony in its fuss and despair frequently builds queen cells not only on larvae which are several hours old but also on those which are already two or three days old, and occasionally, even on drone cells.

Despite all their efforts, bees cannot rear a good queen from such large larvae, particularly those that are three days old. This can be explained by the fact that larvae of bees and of queens of the same age do not receive the same food from the bees. The bees supply queen larvae, from the very first seconds of their life outside their eggs and throughout their larval existence, only with royal jelly. Worker bees' larvae are fed on bee jelly which considerably differs from royal jelly by its chemical composition. Moreover, bees feed their jelly to bee larvae only for two days, never longer. On the remaining four days they receive a kind of chyme made of honey, beebread, bee-jelly and water. So, it is the difference in the quality and quantity of food, in the volume of queen and bee cells, that determines the differences in the external and internal features of the bee and of the queen.

The powerful effect and might of royal jelly can be well demonstrated by the fact that *the bees can still rear a queen from a one-day old bee larva and that queen may be quite good, while a larva of the same age transferred from a queen cell into a bee one can never be reared into a bee.*

A bee larva under 12 hours in age, grafted to the jelly from a queen cell with larva of the same age, can be raised by bees into a queen of the highest fertility and weight. The weight of the queen will be much smaller if she is fed on the jelly from a cell containing an older bee larva. Such a queen will fly out for mating several days later than the former.

Based on this qualitative difference between the jelly of bees and of queens, it can be stated that the bee's organism begins its formation not from the moment its larva is transferred to coarse food, but within the very first hours after it has left the egg.

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So, the jelly of bees and royal jelly are both products of bees' active life, but they differ in their chemical composition and biological activity. So far, the modern science of biology fails to explain this difference. It may exist because nurse bees introduce some additional components to each of these products. Maybe the jellies differ because they are produced by bees of different ages. It is quite possible that the reason may be the same as that for the dissimilarities between milk of cows and of other mammals. In the first postnatal days, these animals are known to feed their calves by colostrum. Later on their mammary glands begin secreting milk of another chemical composition, colour, taste, flavour and consistency. The secretion of the same glands was found to vary with age.

One would think that the biological factor governing both kinds of jelly may be used as the basis for artificial queen-rearing. But, unfortunately, so far it has been underestimated in practice. In breeding queens, beekeepers frequently make use of larvae whose organism already needs to be reconstructed into that of a queen. Occasionally, even emergency queens are employed.

It is true that among emergency queens some may be sufficiently developed. But these can only be queens reared from larvae under one day in age. However, it is not so easy to determine from which emergency queen cells the queens will turn out to be of high quality and in which they will be of poor quality.

It is believed that by leaving only one slightly uncapped queen-cell and cutting out all the other capped cells seven days after the queen's withdrawal, that the single unsealed queen cell will yield the queen of the best quality.

Some people claim that bees construct this cell on the youngest larva, and even on an egg. This supposition may be quite true, but there may be other cases, too. Some of the unsealed queen cells could be filled by the bees not in the very first hours after the colony became motherless, but five or six days later, when the youngest larvae were already two or three days old.

It is quite possible to make a mistake when choosing an emergency queen cell. V. S. Shimanovsky wrote: "I noticed for myself that emergency queen cells are not all filled immediately after the queen is removed, but those composed on the first days are later supplemented with some new ones. In this way, an uncapped queen cell on the eighth day may happen to be built on a worm which is close to such an age when turning it into a queen is practically impossible."

According to G. A. Kozhevnikov, the number of ovarian tubules in emergency queens may often be the same as in swarm ones. However, they are much shorter and contain fewer numbers of chambers,

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occasionally by two or three times. Therefore the fertility of emergency queens is low.

Bees can manage to rear a queen even from a larva which is up to three days old, but she will be of poor quality.

Hence, when breeding queens artificially, one may use larvae right when they leave their eggs, in extreme cases, even when they are not more than several hours old. It would be much better to rear queens right from their own eggs. Then the newly born larvae could immediately, from the very first seconds of their life, be fed on royal jelly. Unfortunately, such queen-breeding technology has not yet been perfected.

Taking into account the queen's natural tendency to lay larger eggs when the colony is preparing for swarming, the conditions provided in artificial queen-breeding are usually similar to those in a swarming colony.

There are several ways to prepare larvae for building them into queen cells. The larvae are either brought to the colony together with the cells they are in, or they are carried in specially made cups.

The bees are shown where to build their queen cells. As soon as a high-breed colony gets ready to accept larvae for queen breeding, the bee-keeper finds in its nest a honeycomb (preferably it should be freshly built because then there will be no pupae, the cells will be easier to shorten and expand) with the youngest larvae (at best, from six to eight hours old). The bees are carefully brushed off the comb. The latter is placed into a portable box and installed indoors with an air temperature of 25 to 30 °C. The air should be sufficiently humid. Such warm and humid conditions are necessary to keep the larvae warm while they are kept outside the nest, and dry, as well as to keep the jelly from becoming too thick.

The comb is arranged on the table in a flat position, with the larvae of the required age on its top. As a rule, the queen begins laying her eggs in the comb from its middle and works in a spiral. Therefore the middle cells will usually house eggs or larvae of somewhat older age than those situated closer to the periphery.

It should also be borne in mind that at first the queen lays her eggs in one side of the comb. Then she moves to the opposite side where the larvae are some hours younger. Considering this peculiar feature of the queen's work, the apiarist can determine in which part of the comb the larvae most suitable for placing the queen cells are located. He cuts out a rectangular piece of the comb which must be 40 mm high and 150 to 200 mm long, depending on the number of larvae desired.

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The upper and lateral sides of the window so made in the comb must be bordered by the cells with the youngest larvae. Using a sharp razor or a surgical scalpel, the terminal edges of the cells are cut off to their halfway mark so as to help the bees reconstruct them into queen cells. After that, all larvae from the cut cells are thrown away. Two of every three larvae are removed from the shortened cells. This measure is necessary to encourage the bees for building larger queen cells and for preventing them from sticking them together. On the opposite side of the comb, all larvae from the end rows (the first two rows) are destroyed, so that the bees cannot build queen cells on older larvae.

As long as the larva remains within the bee cell, even if the latter is shortened, the bees will go on supplying the larva with the same jelly it was receiving before.

The bees are encouraged to start feeding the larvae with royal jelly as soon as possible. Each cell to be built as a queen one is slightly expanded by using a template with its end rounded and polished, its diameter being a little larger than that of the cell. The appearance of such an expanded cell will remind the bees of a cup in a swarm queen cell, and they will accept the larva inside it as that of a queen. The template must be worked very carefully, so as not to disturb the larva.

The comb so prepared is returned to the same colony to be filled with queen cells. Beginning with this moment, the maternal colony turns into a rearing one. The comb is inserted in the centre of the nest, which is its warmest part. This entire operation should not take more than 25 minutes. Then the nest is covered, warmed up, and the colony is left in peace for two or three days.

Under natural conditions, bees, as a rule, set up swarm queen cells in such places where they find no obstacles to build them. By installing a comb with a window cut in it, the beekeeper "shows" his bees where and on which larvae they should build their queen cells.

As soon as a colony receives a comb with high-breed larvae, this comb will immediately attract nurse bees. They accumulate in huge numbers in the cut of the comb where they will start laying their queen cells without any delay.

With this activity in full swing, the colony does not show its sense of motherlessness any longer. It calms down utterly engaged in its work.

Bees often set up queen cells on other combs, too. Therefore, after three days the nest is disassembled and each frame with the brood is carefully examined, and all emergency queen cells are destroyed. This important procedure encourages the colony to concentrate its efforts on tending to queen larvae only. Traditionally, the number of larvae being bred is strictly counted (in the cut part of the comb the bees usually make eight to twelve queen cells). If the number of queen cells

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is smaller, the colony must get another frame with high-breed larvae from another breeding colony, since it may happen that the queen-rearing colony has no larvae of the desired age.

Sometimes, bees can set up emergency queen cells again but on older larvae. Queens from such larvae will develop faster and hatch earlier than from younger ones. It is vital to see that the emergency queen which evolve first do not gnaw out the queen cells with breeding queens and do not kill them. To this end, eight days after the colony becomes motherless, the nest is inspected for the second time to destroy again all emergency queen cells. The frames with the brood must be examined especially thoroughly, so that not a single, not even the tiniest queen cell, remains there.

As noticed by beekeepers, queenless colonies are most eager to set up emergency queen cells on the brood in freshly build combs. As a rule, no queen cells are found on brown combs if there are light-coloured ones. Therefore, the nest of the rearing colony should be made up of brown combs long beforehand.

To have more queens, one cuts not a rectangular window in the comb, but some pieces shaped like isosceles triangles—zigzags. Like a rectangular cut, this one is made in that part of the comb where the larvae are the youngest.

The bees will set up their queen cells along the entire cut. It is not practical to leave more than 20 queen cells, because otherwise the queens will be small and physically weak.

When verifying the number of larvae accepted by the bees to be reared as queens, it is vital to check the amount of food inside the queen cells.

As found in practice, the bees do not tend to all queen larvae equally well. They supply some of them with more jelly and these larvae can develop faster and better, while those receiving less food will lag behind in their growth. The former will turn into large and fertile queens, while the latter will be of poor weight and low fertility.

The difference in the amount of food and its effect upon the larval growth can be observed as early as three to four days after the queen cells are set. Those with larvae of poor growth and with minimal food are eliminated.

For the second time the queen cells are controlled when they are already sealed (extremely long or extremely short ones, as well as those which look abnormal are destroyed). It is dangerous to make abrupt gestures when separating the frame with the queen cells from the grooves of the hive (the bees glue it tightly), brushing off the bees or turning it upside down. One may brush the queen larvae off and even separate them from their food, causing them to perish.

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Queen cells which are 10 or 11 days old are cut out. Though some apiarists recommend it, it is rather risky to do this at an earlier time, for the tender pupae can be easily hurt.

In queen cells of this age, the walls and particularly the base are usually much thinner and weaker than those in swarm queen cells. The former are built on the thin bottoms of bee cells, whereas the later – on the heavy and thick-walled cups made specially for this purpose. In view of this, queen cells made on bee larvae are cut out with special care, so as not to disturb or expose the still immature queens. Each queen cell is cut out together with some part of the comb. The queen cell is strictly set in its vertical position and inserted inside a queen cage where the section containing the food is preliminarily filled with candy (2.5 parts of sugar powder per 1 part of centrifuged honey). Then the queen cell is left in peace to mature, either in the same colony or transferred into the nest of another which is in need of a young queen.

The larvae are taken out together with the cells. To set up new queen cells, the larvae are isolated from the comb together with their cells. To do so, a piece of the comb is cut into narrow one-row strips which are cut into individual cubicles, and then, each of them is cut in half and expanded. The unshortened side of the cell is put into melted wax and attached to a little wooden cartridge $2.5 \times 2.5 \times 0.5$ cm in size. Each cartridge is preliminarily glued to the grafting frame with some wax. The frame usually receives not more than 25 larvae. When all of the larvae are fixed in place the planks with cartridges are turned in such a way that the cells with the larvae face the lower plank of the frame. In this position it is placed in the nest of the nurse colony.

These methods to prepare the larvae are simple and easy for any apiarist to employ, even if he is only beginning his practice of artificial queen-breeding. Reared by this techniques, the queen usually proves to be of sufficiently high quality. However, like with emergency ones, some of them may happen to be inferior. The reason behind this is the same as observed in cases of emergency queens: the queen cells are not set up at once but after an interval of several hours (up to 24 hours) during which the larvae become more mature and receive ordinary food, in other words, not the royal jelly.

Despite all the elasticity and softness of wax, it is not always possible to stretch a bee cell to the dimensions of the cup in a swarm queen cell by using a template. Therefore the bees will never regard all larvae as queen larvae.

Queen cells are similar to swarm ones. Practice provides us with more

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efficient methods for breeding queens which almost do not differ and are sometimes identical to swarm ones. In such cases, the larvae are supplied to the colonies not in the bee cells but in some specially made artificial cups; in other words, the colony seems to be given queen larvae from the very first moment.

This method of preparing larvae involves two operations: to make the bases of the queen cells (the cups), and to place the larvae inside them.

Cups are made by using a template, which is a stick of hardwood with its end polished and oval in shape, and has a diameter of 8 to 9 mm. The template is put into water and then dipped 6-7 mm down into melted and slightly cooled wax (the wax should always be of the best possible quality). The stick is immediately taken out. In three to five seconds the wax hardens up and the template is again immersed in it, this time to a smaller depth. The dipping is repeated five or six times, each time to a smaller depth, so that the base of the cup becomes thicker and warm, like that in a swarm one. The cup with the last layer of wax still unhardened is attached to the cartridge. As soon as the wax hardens up, the template is withdrawn.

One makes as many cups as he needs to rear his queens. In large amateur apiaries templates may have from four to five cores, in commercial queen-breeding farms and in breeding nurseries they may be of 15 sticks, so that the cups may be glued to the cartridges of a whole flank of the grafting frame simultaneously. Automatic templates are employed in the industrial manufacturing of cups.

Before the larvae are transferred, the grafting frame with the cups is inserted for 24 hours in the nest of the colony which will rear the queens. Within this time the bees will get used to the cups, polish them and they will acquire the smell of this colony.

The larvae are transferred from the comb into the cups; the temperature in the room must be 27 to 30 °C and the air of high humidity. Beforehand, each of the cups is filled with a drop of royal jelly. To obtain this jelly, the colony to be rearing the queens is deprived of its queen some 12 to 18 hours before the procedure. During these hours the colony will set up emergency queen cells and the larvae will be fed on the jelly of these cells.

Bearing in mind that bees build their queen cells on larvae of different ages, including those which are two or three days old and even older, the jelly in emergency queen cells will be of a different chemical composition. Therefore, to graft larvae for queen breeding, one uses jelly only from queen cells whose larvae are not older than 12 hours, because the quality of jelly in queen cells with older larvae is greatly inferior. This jelly is diluted with food received by bee larvae before

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their organism becomes transformed into that of a queen. All emergency queen cells are cut out and only the desirable ones are selected.

In everyday practice apiarists sometimes graft queen larvae on honey, which bees never use for queen rearing. Honey will be just an addition to the food prepared by bees themselves for bee larvae by the end of their two-day life. Honey-grafting of larvae considerably deteriorates the quality of queens.

The larvae to be reared into queens are taken from the nest of the breeding (parent) colony, best of all in a brown comb, since the larvae can be better observed there and more easily transferred.

It is more convenient to take the larva from its back by means of a spatula which is a thin metal blade slightly curved at the end. The larva is removed very carefully and, without changing its position, dipped into the cup on the jelly.

From under the larva the spatula is withdrawn in the direction reverse to its dipping, in removing the larva, one lightly touches the bottom of the cup. To learn how to do this job with a jeweler's precision (so that the colony receives the maximum number of larvae), beginners should first practice the procedure working with young drone larvae.

The planks with grafted larvae are turned with their cups down and the frame is installed in the nest of the rearing colony. The latter can be the same from which the larvae were withdrawn, i. e. the parent one, or any other colony which is strong and productive.

As it was claimed quite recently, modern genetics does not support the idea that rearing colonies may influence the future queens' inherited properties.

The material foundation of heredity is embedded in genes. They are passed on to the new organism only through the sexual cells which pass the inherited properties on to the offspring and provide for their transmission from one generation to another.

Bees start feeding the royal jelly to their larvae in the cups from the very first minutes. The thing is that the colony has just been deprived of its emergency queen cells and thus, physiologically, it is already prepared to breed queens. Bees supply their larvae with abundant quantities of food, as they usually do in rearing swarm queens. Queens brought up in this way are, as a rule, well developed and of high fertility.

It is also possible to transfer the larvae on the jelly taken from bee cells, but in such cases they must be regrafted later.

Regrafting the larvae. In recent years, another, more advanced method of queen-breeding has been widely used. It is the so-called

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Bees breeding their queens.

two-stage larvae grafting method. Its essence is the same, but it differs in the following way: the grafted larvae are removed from the queen cells after eight to 10 hours and some new ones are placed in their stead, also of high breed, and as before, of the youngest age. The newcomers immediately find abundant queen-food. Meanwhile, the colony, already tuned for queen-rearing, plunges without any delay into tending to these secondary queens. Now the bees do not hesitate as to which larva to take in and which one reject, as they did 10 hours before. By inertia, they continue to care for the new larvae as they did for the previous ones.

As seen from experience, queens from twice-grafted larvae develop

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very well, in terms of weight and fertility they are in no way inferior to the best of swarm queens.

The rearing colony is no longer disturbed until the day the queen cells are to be withdrawn, except for two control inspections. The queens evolved from these queen cells are usually examined carefully. Some of them may happen to be small (perhaps, due to insufficient food), their wings may be underdeveloped, their hind legs may lack claws. Such queens are sorted out.

So, from the same breeding material, bees can rear queens of different quality. To rear queens of high fertility and good inheritance artificially, it is necessary to take the larvae from the best colonies with outstanding characteristics. The larvae must be raised under conditions close to those in which swarm queens are reared, i. e. in a colony of completed growth, abundant honey and bee bread, great quantities of young bees and brood of different ages.

Supersedure. The queen in a bee colony does a colossal job, indeed. She begins laying eggs when the colony is still wintering and finishes her hard work only in autumn. The queen labours seven or eight months of the year, day and night with only short intervals for receiving food from the bees or for brief moments of rest. She spends a lot of energy, particularly when the colony is accumulating its reserves to be used for forming the swarm and the multithousand army of field foragers to gather the harvest from the nectar plants during the main honey flow. At this time, the queen works to her fullest biological capacity. The weight of the eggs she lays in one day may reach and frequently even exceed her own. How astonishing must her fertility be and how endless her energy!

To be able to lay such a huge mass of eggs, it must be a queen with extremely developed ovaries, having the maximum number of ovarian tubules and chambers in them. This queen must also be young.

With time, her greatest capacity for producing and fertilizing eggs, her energy for laying them fade out and her sperm reserves decrease. The queen is becoming older, wearing out physiologically and physically. This ageing process becomes more intense, the longer the queen works at her fullest capacity.

Such hectic work by the queen is encouraged by the mighty power of the colony, a good honey harvest in nature, abundant stores of food in the nest and the hive which allows the endless expansion of the nest. Under these favourable conditions, the queen can maintain her high rate of egg-laying for about two years. As seen from practice since the ageing process of queens adversely affects their egg-formation, colonies can be their strongest and most productive only if their

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queens are not older than two years in age. Their reserve of spermatozooids is depleted, too. The egg production in such queens and the productivity in the colonies drastically diminish.

Particularly severe is the physiological exhaustion of queens in multiple-storey hives where they have to work most intensely.

Bee colonies will always retain their high economic value if their queens are changed at least every two winters, but only after the colony completes its growth and is prepared for the main honey flow.

Bees themselves also feel when their queens have worn out and their rate of egg-laying has decreased, especially during their spring growth (frequently at its onset). Nature has endowed them even with this wonderful capacity. Bees do not permit such an unreliable queen to continue their stock and they replace her.

It is frequently the case when a well-working queen suddenly reduces her egg-laying (it may become ill or physically injured). If this situation threatens the future of the colony, the bees will replace such a queen, too. This biological property of honeybees was, of course, very important for their natural evolution as a species. It was reinforced during the course of their development and finally became manifested in an act of natural supersedure. Even though the old queen still works the bees rear a new one, not for the sake of the swarm, as they do during swarming, but for the sake of themselves.

This supersedure results from the critical condition the colony is in. The most surprising thing is that the bees begin superseding immediately, as soon as they feel that their existence is endangered. But if the queen does not decrease her egg-laying, and the colony has not yet managed to rear its drones by the day the queen cells must be sealed, then the bees will destroy the queen cells and after a certain period of time in their stead build some new ones. This process may last very long, until nature provides the most favourable conditions for rearing a good queen and until the colony's drones appear.

Bees rear their queen without preparing for swarming. This can be proved by their active flights to gather honey, by their devotion to comb-building and by the minimum number of queen cells (only one or two of them). It is common knowledge that, in preparing for swarming, bees drastically reduce their activities and the number of queen cells they are building increase by several times.

While superseding, bees build queen cells of regular shape and of very large size. After the queens emerge from their cells, there always remains much unused food. Such queens are usually of good physical development, maximum weight and high fertility. Bees rear them from eggs, like they do swarm queens.

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“If an emergency queen is initiated while the old one was still alive and can govern the new queen’s regeneration,”—P. I. Prokopovich, an outstanding apiarist of the XIX century wrote about superseding, —“in such cases, emergency queens will in no way differ from swarm ones.”

Characteristic of this natural supersedure is also that the young queen leaves her cell when the colony is still ruled by the old queen. While the young queen is being reared, there is no hostility between the two, no excited singing is heard from the hive. Moreover, the young queen frequently mates and starts egg-laying while the old one is still working. One can often see the mother and daughter peacefully coexisting for some days, and even weeks. Both of them may happen to lay their eggs on the very same comb. Then the old queen disappears.

Beekeepers may often injure the queens with the purpose of provoking a supersedure.

There is another natural act of supersedure in honeybees’ colonies. This method is the principal one: it is swarming. Old queens leave the hive along with the swarms, the young ones remain in the nest to continue the breed.

Bee colonies are known to start preparing for swarming long beforehand but they acquire their capacity for colony-division only at the end of their growth period. In other words, they can actually form new colonies after they accumulate huge reserves of bees and their nests are overloaded with brood and food. The ratio between their capped and uncapped brood is usually 9 : 1 or even higher. At this time, the colonies become biologically mature.

This qualitative condition of queens and colonies should be taken into account when one plans to supersede artificially.

A queen of one breed is replaced by that of another. It is sometimes necessary to replace not only exhausted queens (those of high breed and progenitors are usually kept until they completely wear out), and not only by queens of the same stock, but also by queens of another breed specially received from queen-breeding farms.

Many apiarists in the south keep gray mountain Caucasian bees or hybrids of local and gray mountain bees. Beekeepers in the northern regions usually work with queens of the Middle-Russian forest breed.

Gray mountain Caucasian bees are peaceful and do not swarm often. In areas where the honey harvest from mixed grass is not rich but long, they can gather more honey than the local bees do. Therefore this breed is usually preferred in areas with this type of honey harvest.

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Gray mountain queens are also used to cross-breed with local bees. The following combination was found to be the most successful: the queen is of the gray mountain breed and the drones are of the Middle-Russian one. The offspring inherited the best properties of their parents: the high winter resistance and great working capacity from the Middle-Russian breed and the peaceful character and low tendency for swarming—from the gray mountain breed. The hybrid colonies of the first generation can gather 40-50% more honey than a colony of the elite strain (of pure blood) originating from either of the breeds.

Good results can be obtained when cross-breeding bees of the same breed but from geographic zones situated far from each other. For example, cross-breeding of Middle-Russian bees from the Far East with those from Siberia can yield colonies of the highest productivity. Such bees seem to be genetically different, with their inheritance enriched and therefore they possess a combination of the most valuable biological properties. They can rapidly gain weight before the main honey flow and are capable of mobilizing all of their reserves to begin honey collecting; they demonstrate an excellent resistance against long and severe winters.

Queens of one geographic breed are replaced by those of another when the new breed is preferred or when hybrid colonies from cross-breeding are desired.

European apiarists widely practice crossing Carniolan bees with dark Middle-European or Italian ones.

As a rule, hybrid colonies prove to be more productive chiefly in their first generation. To prevent their next generations from being less productive, beekeepers practice back crossing.

In the first year, queens of the local breed in all colonies are replaced by virgin queens of another breed, say, by Gray Mountain ones. These queens will mate with the local drones of the same or of other apiaries (before the queens are replaced, each colony in these apiaries will have already raised its own local drones), and will form hybrid colonies of the first generation (direct crossing). In a year or two, it will be time to replace the queens of the hybrid colonies. Then virgin queens of the local strain are brought to the apiary, or are reared in a pure-breed colony whose queen was not replaced. This time, the young local queens will mate with the gray mountain drones and will again form hybrid colonies of the first generation but back-crossed.

Such successive alteration of queens is employed to preclude breeding hybrid colonies of the second, and moreover, of the third generation. This may happen if the queens for the subsequent supercedure appear in hybrid colonies of the first generation and mate with drones who are their own brothers from the same apiary.

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Such a selective breeding programme will be more effective if queens have more chances to mate with drones of a strictly definite strain. It is highly desirable that apiarists living within the same zone of their queens and drones' flight should cooperate and supersede following a common and agreed upon plan.

Beekeeping societies play a great role in the planning of efficient and deliberate selection.

Desirable mating can also be achieved by rearing queens and drones at an earlier time, when ordinary, non-progenic colonies have not raised their drones yet.

Maximum weight is gained by colonies with young queens. Their period of growth lasts longer than in colonies with old queens, sometimes till the very onset of the main honey flow. Therefore, as a rule, the instinct for swarming in such colonies does not intensify and swarming does not occur. A colony with a young queen builds fewer drone combs, it responds easily to anti-swarm techniques, rears larger quantities of young bees after the main honey flow and can withstand the winter season better. Young queens do not perish during wintering, except in cases of heavy infections, such as nosema and acarine diseases or varroaosis.

The colony does not always accept the queen. There are several ways of artificially changing queens. Some of them call for the preliminary removal of the old queen and the subsequent introduction of the young one, others involve the technique of requeening; a number of methods are based on the antagonism of the queens and their biological intolerance of each other. But irrespective of the technique adopted, none will ever prove to be fruitful if the beekeeper disregards the physiological conditions of the colony and its queen.

It is much easier to change the queen in a colony when it is entirely engaged in collecting honey (at this time the instinct of food accumulation dominates), than during its growth stage when all of its activities are governed by the instinct of reproduction. At this stage the queen is the focus of the bees' attention. The colony hurries to accumulate as much power as it can before all nectar plants start blooming. At this time some colonies may even tolerate queens with physical drawbacks, trying to delay their future replacement. By the onset of the main honey flow, colonies have usually completed their stages of growth and swarming. During the main honey flow, their care for queens loses its intensity, and the stronger is their desire to gather all the honey currently available, the more indifferent they become towards their queens. Almost all bees, beginning with their fifth day of life, are now involved in collecting nectar and processing it into

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honey. At this time one can easily take any queen from the comb and replace her by a young and more fertile one which has just been laying eggs in her own nest (nucleus), and even unfertilized queen can be put in the colony now, since deeply engaged in honey collection, the colony will hardly notice that its queen was replaced. For the time being, the queen does not seem to exist for the bees.

At the time of no honey flow, and particularly in the first days after an interruption in the honey harvest, colonies become extremely excited. They get equally nervous when their property is robbed by robber bees, or when attacked by bee wolves (wasps), dragon flies or bee-eaters. Any attempt to interfere in their life at such moments irritates them still more. One cannot even dream of giving them a new queen, since they would never accept a new one in their condition of extreme nervousness and alarm. When bees are happy and, so to speak, in an excellent mood, this greatly favours their acceptance of a new queen.

Bees welcome new queens when they find themselves on the verge of doom. If a colony has just been dequeened or its queen has died, the bees feel greatly alarmed, their rhythm of work and life is badly disturbed, they stop their flying routine and comb construction. The bees start running on the flight board and outside the hive and cease keeping guard of their nest. For some time the colony ceases to be a colony. If a queen is introduced to this colony at this very moment, even without any precautions (right through the flight entrance or directly onto the comb), the bees will eagerly accept her, and the life in the hive will normalize.

But if by the time of a new queen's introduction the same colony has become quiet, the bees may not accept the new queen and react very hostile. Their mood changes so sharply immediately after the young brood of their nest is laid with queen cells. Feeling that their future is no longer in danger, the colony is no longer in need of any queen.

In practice, there are frequent cases when a colony remains without its queen, but is unable to rear itself another one: it has no young brood (say, it became queenless during wintering, or its queen got lost during her nuptial flight). In such a colony the state of despair and alarm will last not five or six hours, as in the artificial dequeening in colonies with their brood uncapped, but for several days. It will not be difficult to introduce a new queen in such a colony during this entire period. But if one fails to do it during this time, the state of alarm and despair will soon come to an end.

In their struggle for existence, worker bees perform the function of the queen themselves. In fact, they are also females, but their sexual

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system is underdeveloped. When the queen is absent for a long while, their sexual instinct, which is very weak but still alive in them, acquires new strength. And as soon as these worker bees start laying eggs, the colony feels completely secure and safe and behaves very aggressively towards an alien queen.

So, the same colony may accept a new queen quite eagerly in one case and meet her with great hostility in another. To know for sure the physiological condition of the colony and to be skillful enough to provide conditions favouring the colony's acceptance of the queen – this is one of the most important things in rational beekeeping.

The queen obviously reduces her egg-laying when the bees start preparing for swarming (this may be the case in colonies which do not yet show any obvious signs of an increased swarming instinct). This time is regarded as the best for replacing the old queen by a young one. When a colony receives a young energetic queen which can rapidly increase her egg-laying, there is no more danger that its swarming instinct will intensify. The colony again enters a growth state. As a result, its forces will be preserved, it will retain its high working capacity during the main honey flow and will be able to prepare well for the coming winter.

If the queen is replaced earlier, the colony's growth will inevitably be affected adversely: some time will be necessary to put the new queen in and to have her accepted; besides, the old queen's egg-laying will be interrupted at its very summit, while as a rule, the new queen never begins laying eggs of her own immediately.

The heaviest losses in brood will be suffered by the colony whose queen is replaced by a virgin one, or even by a fertile queen received from a nursery and immediately put into the nest. During transportation, the queen's ovaries stop functioning for a while and no eggs are formed; the queen may even lose weight due to malnourishment. And it may take several days until this queen is again able to lay eggs, and moreover, is capable of working as well as her predecessor did.

To avoid any interval in egg-laying, American and Canadian apiarists use the following technique for replacing old queens by new ones. When colony occupies two storeys of the Langstroth-Root hive and the larger part of their frames are filled with brood, a screen board is installed between the frames. Four days later, the beekeeper determines in which part of the hive the queen is. In a section without eggs, there will be no queen.

The storey with the queen is placed aside on a reserve bottom. The queenless part of the nest remains intact and receives a queen or a queen cell. On the day after the bees fly into the storey, a second one is arranged on its top. The second storey contains combs. It is covered

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with a ceiling and its hole for bee escaping is closed with the screen board. The storey with the old queen in it is placed on this ceiling.

After the young queen is fertilized and begins to lay eggs, the old queen remains on the top and continues to work for two more weeks. Then she is found and destroyed, and the ceiling with the screen board is removed.

This technique precludes any break in the egg-laying. Moreover, it enables the beekeeper to obtain additionally essential reserves of brood.

When the honey harvest is long (two or three in succession), it is feasible to replace old queens by young ones at the onset of the honey flow when the bees are already involved in honey collection. The supersedure will disturb the working rhythm in the colony for a while. To tend to the open brood remaining from the old queen and to that from the new one, the colony will have to allocate a certain number of nurse bees. But neither of these jobs will affect honey collection.

Characteristic of a long honey harvest are smoothly increasing honey arrivals to the hives. The latter will gradually gain weight until maximum weight is reached; then the bees will seal most of the cells containing uncapped brood. During intense honey collection the queen's activity is in some way restricted by the bees themselves; the colony mobilizes almost all of its reserves for gathering honey. The first generations of bees reared from the young queen also manage to participate.

In the two-queen technique, the queens are replaced at the onset of the second main honey flow, when it becomes necessary to strengthen the basic colonies with special nuclei. If the honey flow is short in time but intense, the old queens are usually replaced by fertile and young ones at the beginning of the honey harvest. Colonies with young and fertile queens work more energetically than those with old ones.

In modern beekeeping, when not one but a number of main honey flows are used, it is very important to maintain bee colonies which are consistently strong and have a lot of brood. To achieve this goal, old fertile queens are replaced by young fertile ones. No break in egg-laying is permitted.

Beekeepers have devised quite a few methods for replacing old queens by young ones, but not all of these methods have been confirmed by practice. Some of them have not gained much support because they are extremely labour-consuming. For example, we can mention the method of rearing emergency queens which every colony breeds for itself. But there is no guarantee that these emergency

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queens will by all means exceed the old ones in terms of their qualities. Some other methods, though not so labour-consuming, still did not prove to be very fruitful in terms of the bees' response to and acceptance of new queens.

Current apiculture employs more widely such methods of superseding which demand less labour, are reliable and do not interrupt the brood-rearing.

The most popular are techniques which do not require searching for the old queens which are to be replaced.

Together with the nucleus. The bees quietly accept a new queen when her physiological state is almost the same as that of their former queen, i. e. both queens are not only fertile but already laying eggs. Their physiological conditions will differ if the nest of the colony whose queen is replaced is rich in uncapped brood, and particularly in eggs, but the new queen, though quite fertile, has not yet started egg-laying. It seems likely that it is for this reason that the bees do not accept every queen introduced in their nest right after her arrival from the nursery.

Before a queen is set into another colony, she is provided with the time and opportunity to start egg-laying in a nucleus.

Nuclei containing young fertile queens are attached to the colonies whose queens are to be replaced. This is usually done at the beginning of a long and productive honey harvest. The physiological condition of the colonies whose queens must be replaced is also taken into account. This condition can never be the same even in colonies which seem to have finished their growth and do not demonstrate any signs of swarming. In some colonies the flight for honey is intensive and grows still more powerful as the honey harvest increases; the flight of other colonies is much more passive. If one looks into the combs of the former, he will find them well whitewashed and properly receiving the fresh honey; in the nests of the latter everything is only beginning. This difference is not so much due to the might and power of the colonies but rather to the fact that their transitions from one physiological state to another do not occur simultaneously. Colonies should be regarded as completely ready to supersede, when all their activities are governed by the instinct of food accumulation.

As the bees spend more energy on their honey flights, their indifference towards their queens constantly increases. This fact favours the superseding.

Another important factor must also be taken into account. *The colony will be well and normally inclined to gather honey only if it has a fertile queen and plenty of brood of all ages during honey harvesting.* And

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to replace the old queen for a young and fertile one, without disturbing the physiological state of the colony, is quite easy at this time by supplying it with a nucleus.

The procedure is as follows. If the nucleus with the young queen is inside vertical hive above the colony's nest, the horizontal partition separating them is removed and replaced with a sheet of paper. The queens are not searched for. In a horizontal hive, the diaphragm is replaced by a frame with empty combs, or the nest of the nucleus, its combs untouched, is carefully pushed into that of the basic colony.

The best time to conduct this procedure is during the bees' most active honey flight when practically all members of the colony are busy with the gathering and processing of nectar. Not to disturb the traditional rhythm of the colony's life and that of the nucleus, the use of smokers should be resorted to only in the case of great necessity.

Being absorbed in their work, the colonies will barely notice that their colony and nucleus are being joined. Judging by the fact that in the majority of cases bees throw only old queens out of the hives, it may be assumed that they perish in their duel with the young queens.

American apiarists introduce new queens along with a part of the nucleus nest. From the nucleus, two frames with the bees, brood and queen are removed and inserted into the middle of the queenless colony's nest. In this case there is no danger of the new queen being killed because her own bees steadily defend her, while she goes on working unceasingly. And the bees usually accept an egg-laying queen with greater eagerness.

Nuclei, whose queens will be used later to replace the rejected ones, are placed on queen cells, on unfertilized queens or on fertile ones received from bee-nurseries. It is worth mentioning that bees of some breeds are not very happy to accept queens of other breeds. For example, pure bred Middle-Russian bees would reject gray mountain Caucasian queens, and bees of the latter strain would not welcome those of the former. To guarantee that the bees will accept peacefully the young queens put in their nest, by the time the queens are introduced to the nuclei the anxiety of the queenless colony must be evident. It is very important to see that no young larvae or eggs get inside these colonies, because then the bees may use them to rear emergency queen cells and will become very aggressive towards the new queens.

Inside the queen cell. Under natural conditions, the bees usually replace their old queen not by one borrowed from the outside, but by one reared by the colony, which is gradually getting ready for this change-over. Based on this biological feature of honeybees, bee-keepers in their everyday practice have designed a technique to replace

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queens by queen cells. The essence of this technique is that a colony is given a queen cell without removing the old queen.

To this end, one takes a mature and good queen cell from the rearing colony or from a highly productive swarming one. Together with the cage, and in case of a swarm queen cell – together with a piece of comb, the queen cell is installed in the middle of one of the streets (most desirable in the second or third street from the edge of a horizontal hive or in the upper storey of a multiple-storey one). It should be in the midst of the zone with honey and as far as possible from the brooding part of the nest where the queen is working at the moment.

The queen cell is fixed at a small angle in such a way that the beekeeper can see the emergence of the queen without removing the queen cell. In 24 hours the nest is opened above the queen cell to examine the latter. If it is undamaged (no gnawed holes on its side), it means that the bees have accepted it and one may hope that its queen will come out all right and the colony will have the desirable supersedure.

It does not always happen that a killed queen is thrown out of the hive immediately after the young one appears. On this basis, one may suggest that both the young and the old queens for some time co-exist quite peacefully, just like in natural supersedures. In such cases, the egg-laying in the colony is uninterrupted.

When not inclined to accept a new queen, the bees gnaw the queen cell out, kill the new queen inside or allow the old queen to do this.

The bees may reject the queen cell because it is not quite suitable for them (it may be distorted in shape or have some alien smell from the beekeeper's hands). In this case the colony is offered another queen cell. The new queen cell is also inserted into the second street but from the opposite side of the nest. After another 24 hours the state of the queen cell is checked again. If the bees have gnawed it again, it can be concluded that the colony's own queen is still in good physical condition, her sperm stores are sufficiently large and so far, the bees do not want to replace her at all.

As a rule, out of every ten queen cells so inserted, the bees accept seven or eight. The highest percentage of acceptance is observed during honey harvesting. The availability of the honey harvest is one of the most important conditions for a proper acceptance of new queen cells.

Queen cells are also supplied in so-called Titov cubicles. Their food opening is made through and closed with a tin shutter from the outside. Before the queen cell is put in, the food opening is filled with soft candy. After the queen emerges from the queen cell and is welcomed peacefully by the colony, the beekeeper removes the shutter. The bees

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will then liberate the area around the food opening and let the queen out.

The queens, governed by their inborn hatred towards each other, will immediately start their duel. One of them dies. As a rule, the young queen always wins. She is physically stronger and more agile than the one laying eggs; her abdomen is free from eggs and she can move easily in any way, therefore she is the first to strike. Besides, this inborn hatred and the desire to set up her own family are much stronger in the young queen than in the old one, whose activities are now governed by her maternal instincts.

And it is the young queen who becomes the progenitor of the future colony.

According to anatomic research, the poison of the young queen and that of the old one are different. In the young queen it is liquid and transparent, while in the old queen it is thick, dense, dark in colour and does not pass into the stinging canal. It is believed that if the old queen ever does manage to be the first to strike, the sting would not prove to be fatal: the old queen is not able to inject her poison. In addition, it is most likely that this poison has already lost its former physiological properties. As usual, nature in this case, too, gives preference to the young organism and protects it.

When a colony is pleased with its own queen, it will meet the young one quite aggressively and will surround, forming a ball, and suffocate her.

Some apiarists, before putting their queen cells into nests, carefully wrap them in funnel-shaped covers made of a metal grid or soft wire. Such covers protect queen cells from all sides, since they are left open only from the bottom.

As a rule, the bees or the queen gnaw the queen cell from its lateral side, above the queen's abdomen, which is the most vulnerable place of her body and the easiest to be stricken with the deadly sting. They never gnaw the queen cell from its bottom where the queen's head and chest are well armoured with chitine.

The method for replacing old queens by new ones by using queen cells and without removing the old queen has found its application not only in amateur bee-yards but in commercial bee-farms as well. This technique is simple and not labour-consuming. It permits the bees to decide for themselves whether to have their queen replaced or to leave her in the colony for a while longer.

Bees are surprisingly capable of detecting certain signs by which they assess the queen's quality and fertility. When choosing a queen among several, they usually give preference to the one who proves to be the heaviest in weight and the most powerful. The line marking the

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boundary between her dark-coloured dorsal part and the lighter coloured ventral part is usually very distinct. Such queens are in fact of the highest fertility.

The queen is received by flying bees. There are frequent cases when old queens in multiple-storey hives are replaced in the following way. The multiple-storey hive is put aside and in its stead a one-storey hive is installed, its combs filled with some insignificant amount of honey and beebread. These combs are used to attract a young and fertile queen. Then the storey is covered with a ceiling, upon which the former storey, but now bottomless, is installed. The very first bees returning from the field and failing to find their home and beloved nest, bees and queen, will be at a loss and confused. The same feeling will be experienced by their sisters following them from the field. But their confusion will not last long. Finding a queen, though not that of their own, inside their home, the bees will gradually calm down.

By the end of the day the bees will have all returned to their hive, but by this time a new colony will have been virtually formed in the lower storey of the hive. The life of this new colony will soon become quite normal. In this way, one can manage to introduce his new queens even when there is no honey harvest or during late summer. But in such cases it is feasible to insert into the nest one or two combs containing liquid food. Then the bees will primarily pay their attention not to the queen but to the honey. And, working with food, they will by and by get used to their new queen.

As soon as the colony with the accepted queen starts working in the field, the nest of the upper, parent colony is attached to it by a sheet of paper. Now the bees are offered a chance to choose one queen out of the two. As a rule, their preference is in favour of the young queen.

This technique can also be employed in a long hive. The nest for the colony formed of young bees is separated from one of the lateral sides, so that the flight entrance is in the back wall. To attract old bees to this section, the hive is turned 180°. Now the flight entrance for the newly formed colony is in the place of that just used by the main colony.

Beekeepers often use supersedure by preliminarily removing old queens and introducing young ones through special cells or little caps. The most popular in this country and abroad are the Titov cubicle and package-cells.

Inside the cubicle. This technique is based on the bees' preliminary acquaintance with the queen and on their liberating her from the queen cell while they feed her.

Man-Bred Queens and Natural Swarm Ones

The queen to be replaced is found and removed. In her stead, a cubicle with a young fertile queen is installed in the middle street. The bees establish their contacts with the young queen through the grid walls of the cubicle, and within one or two days they gradually get used to her.

To be more sure the queen will be accepted, the bees are granted the possibility to set her free by themselves. To this end, the shutter in the cubicle is left opened.

Having acquired admission to the food inside the cubicle, the bees eagerly eat it, and in this way pave the way for the queen's release. It has been noticed that the bees which set the queen free from her cubicle by themselves never suffocate her with their bodies but accept her peacefully and quietly.

A. E. Titov, the designer of this cubicle technique, explains the success of his method in the following way. The process of freeing the cubicle from its food is accomplished not only by the bees but by the queen too. In their joint efforts they establish close feeding contacts, and thus become really friendly.

Sometimes the removed queen is enclosed into a cubicle and left temporarily in the nest. Soon the queen's retinue gets attracted to her and begins supplying her with food. Eight hours later the cubicle is carefully taken out (the beekeeper's hands must be clean and have no alien smell) and the queen is removed. The food section of the cubicle is filled with candy and closed with a shutter. Then the young queen is let into the cubicle which is again inserted in its place.

On the next morning the cubicle with the young queen is carefully removed, so as not to brush the bees from its surface. If the bees behave quietly and seem not to notice anything while engaged in forcing their proboscises through the grid to offer food to the queen, this means they are in quite a peaceful mood towards the queen. Then the feeding hole is opened to them. The empty cubicle is withdrawn and the colony is left undisturbed for some three or four days during which the queen calms down completely and starts egg-laying.

When the queen introduced is unfertilized, the colony is not disturbed for seven to ten days. During this period the queen starts her mating hunt, get fertilized and will then begin to lay eggs. Any interference in the colony's life may frighten the queen and delay her orientation flight and mating.

In his inspection of the cubicle the beekeeper may sometimes notice the bees' hostility toward the queen which will be revealed in their irritation and nervous running about the grid. In this case they will force their mandibles through the grid as if trying to catch the queen by her wings, while she does her best to escape them somewhere at the top,

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near the cubicle shutter, as far beyond reach as possible. There may happen to be no bees on the cubicle at all (this means they are trying to kill the queen by starvation). The bees may also attempt to glue the cubicle with their propolis as if trying to immure the queen there. In all these cases the beekeeper must not let the queen out. The bees will surround her and suffocate her. Either such a queen does not suit the bees in some way, or they have already laid their emergency queen cells.

In this situation the cubicle with the queen is taken away. The nest is inspected, the queen cells are destroyed. The colony is offered another queen. The cubicle is now set between the combs with young bees. If the queen is rejected for the second time, the supersedure is postponed for some eight or nine days until the emergency queen cells and the entire uncapped brood are sealed. After that the queen cells are eliminated. In its hopeless state of despair, the colony will accept any queen.

In a travelling cage the hole for the queen's exit is closed with some sugar-honey candy. Then the cubicle with the queen and her accompanying bees is arranged on the colony's nest without any precautions. The bees will eat the candy and let the queen and her retinue out.

Under the cap. Instead of the cubicle, one often employs the cap. When the old queen is removed and the colony begins showing its anxiety over being motherless, the beekeeper may find in the nest a comb with its brood ready to leave. Using a jet of smoke, the comb is slightly fumigated in the place where some cells are already brood-free and the others have their bees just hatching. The old bees will not tolerate the smoke and will fly up or run away. The young ones will remain. One or two dozen of these bees will receive the queen; then the group is covered by a cap. It is important to see that the cap covers several cells containing honey.

As compared with the old bees, the young ones are more peacefully minded towards an alien queen. Having contacted her, they will acquire her smell (the queen's substance) and through the grid pass it on to the remaining bees of the colony. When liberated from under the cap, the queen will enter the colony not alone but, so to speak, with her own personal guard. After one or two days the cap is removed. If the introduced queen was already fertile, she may have already laid eggs in the comb during this time and her egg-laying will make the colony completely friendly towards her.

So, *the basis for any successful acceptance of new queens is the colony's proper condition favouring their reception, the physiological*

Man-Bred Queens and Natural Swarm Ones

exhaustion of the old queen to be replaced, and the availability of honey harvest in nature. If the old queen is strong and works well, the bees will not accept the new one and will kill her before she meets their own queen.

Introducing a new queen in queenless colonies. Young queens are often put in not only to replace those which are worn out or of low productivity, but also into such colonies that for some reasons lost their queens but have failed to rear new ones. For example, a swarming colony may remain queenless. If the swarm is ready near the day of the young queen's maturity, the entire open brood will have been sealed. If the young queen does not return home after her nuptial flight, the colony will have no opportunity to rear itself a new one and will become queenless. Then, in their struggle for existence, the working bees will act as a queen. But only inferior drones can develop from their eggs. That is why such a colony will be called a colony with laying workers.

If a colony loses its queen during wintering, especially in the first winter months, it will tolerate the whole winter very poorly. The bees will feel continuously excited and alarmed, their cluster will be loose and unable to keep them warm, they will use more food. At the end of such a winter there will be many dead bees. The bees still remaining alive will not be capable of doing any useful jobs in the hive, particularly to tend to the brood. Some two or three weeks after their spring flight they will also perish.

Queenless colonies and colonies with laying workers are sources of infection and robbery. Such colonies, likewise such artificial swarms and nuclei whose queens got lost during their nuptial flights, are eliminated. At the warmest time of the day the hive with a colony with laying workers is taken from the bee-yard, the bees are brushed from the combs onto the grass. The hive and its support are removed. On returning to the place where their home traditionally was, and failing to find it there, the bees will fly over the apiary. Their instinct for existence will drive them to other bees' homes, but not to steal food so as to save their own lives. The bees will join the colonies living in these hives and become equal members. They will accept obediently the rules and order of their new home and thereby earn the right to share their food and shelter.

Shelterless bees usually attain a typical position, occupying the flight board of the hive: they raise their abdomens up, open their scent glands, spread their little wings and flap them slowly, and by short steps approach the flight entrance. The secretion of their glands has a special unifying effect. The watch guard of the hive they

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approach does not attack them, unlike in case of robber bees. On the contrary, the guards begin smelling the new arrivals and caress them. After that the shelterless and homeless bees are allowed to enter their new quarters. Their reflex to the old home, as it happens in swarming bees, fades, and they will never again return to the place of their old residence.

The bees, which do not leave the place where they were brushed from the hive, are destroyed. As a rule, the remaining bees are those which are physically weakened, or those which became too heavy after their egg-laying.

A colony with laying workers but of some interest for an amateur apiarist, before it has become completely weakened, can be improved by keeping it without food and nest for two or three days.

In the evening, when the sun is setting, all bees of this colony are brushed from the combs into a box where a special window for ventilation is previously cut (250 × 250 mm). From the inside the window is grated with a metal thick grid. The box with the bees is carried away to some cold and dark place. The nest of this colony (the frames with the drone brood) is melted into wax. The frames with the honey are retained in the hive. To guarantee the security of the colony's honey against robber bees and to preclude any possibility for wax moths to penetrate the hive, the flight entrances are tightly closed with shutters.

The colony with laying workers is in most difficult conditions: it has no food and no nest, it is isolated from the outside world, and it is deprived of any chance to provide itself with fodder. During their starvation, the bees which laid eggs lose the activity of their sexual organs. Such a colony will later feel at ease in accepting a new queen. She will be allowed to contact the bees without any precautionary measures but only after they starve for two or three days. As soon as the bees start falling off, in other words, dying with hunger (one can notice it by looking through the ventilation window of the box), they will be brought back to their old hive which will be equipped beforehand with one or two frames of ripen (ready to emerge) brood and food taken from some other colony.

So, the queen is the heart of the colony, its most important organ. The stronger and more fertile she is, the faster grows the colony. A queen with good inherited properties, upon mating with high-breed drones, will produce offspring of high productivity. The power of any colony is determined by the youth of its queen.

The Instinct of Food Accumulation Is All-Powerful. The Bees Prepare to Gather the Main Honey Flow



Honeybees are inseparable from the plant kingdom. Flowering plants provide them with food. The bees use them to prepare their large reserves of fodder. Over the course of evolution, plants have developed the trait of blossoming and multiplying at different times: some in spring, others in summer, still others in autumn. In the overwhelming majority of higher plants, the blossoming phase begins in late spring and ends in summer. In other words, it occurs under the most favourable conditions.

The period when nectar plants are in full bloom and during which bees gather the maximum quantity of nectar is called the main honey flow in beekeeping. During their evolution honeybees also tried to adapt themselves to the phases of development in flowering plants. While the plants responsible for the main honey flow are growing, in other words, are gaining in vegetative weight and mass and are preparing for blossoming, the bees undergo two stages in their progress. Using the nectar and pollen of the plants which have already emerged from their phase of growth, bee colonies complete their growth and swarming. By the appearance of nectar plants responsible for the main honey flow, they already enter a new physiological state which depends completely on their instinct of food accumulation.

The instinct for swarming may utterly govern some colonies, almost suppressing their flying and building activities. At the same time, with the same weather and honey-gathering conditions, this instinct will only slightly rule some other colonies, and may remain latent in individual (unswarming) colonies. The instinct of food gathering is strong virtually throughout the entire season. At the time when the major nectar plants are in full bloom, this instinct dominates over all others. This instinct is so powerful that it induces any colony to honey gathering, no matter what state the colony is in, even if it is in a state of swarming. This is especially so when the honey flow is strong. Therefore, in colonies constantly enjoying the conditions of

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productive honey harvests (thanks to the bees' systematic migrations to nectar plants) the swarming instinct fades and they never swarm.

As N. M. Vitvitsky wrote, "The working bees' greediness for honey accumulation exceeds any human idea of assiduity in other animals. This greediness obviously intensifies in honeybees mainly at the time when the amount of sweet liquid juice in the cups of nectar flowers considerably increases."

The phase during which plants blossom, including nectar plants, is the shortest of all the preceding growth and development stages. It is shorter than the stages when the yield is developing and ripening. Within this extremely brief period of abundant blossoming, the bees must gather such quantities of honey which will be sufficient to feed them throughout the long autumn-winter and early spring. Therefore the bees are in a hurry to harvest all the honey they can. Their honey flights frequently begin at sunrise and finish after sunset. Bees have been known to fly to blossoming lindens even during moonlit nights. Honeybees have historically elaborated a specific capacity to respond acutely to the blossoming of plants abundant in pollen or nectar. By the onset of this blossom they manage to accumulate large reserves which they do not lose in swarming. If the situation were different, honeybees would remain without food and finally die from starvation. That is why honeybee colonies, irrespective of the zone they live in, usually hurry up to complete their growth and swarming before the onset of the main honey flow, so as to replenish any reserves, that were lost during swarming, at the cost of the accumulated brood of all ages; then their working capacity will be high.

The conditions in nature may frequently provide for longer or shorter phases of plant growth. During some period of spring the air may warm up by a few degrees, as compared to the traditional conditions in this locality, and this situation may last for a long while. As a result, the local plants will necessarily speed up their growth and their blossoming phase will start earlier. The higher the air temperature and the longer its effects, the earlier the plants will bloom. There can be cases when nectar plants participating in the main honey flow begin blossoming two weeks earlier than usual. Many bee colonies may not be properly prepared yet for such an early onset of the main honey flow. Some of them, which were insufficiently strong from the spring, are still in a growth stage; others, which are stronger, may already be driven by a heightened swarming instinct.

A cold spring, on the contrary, slows down the growth and development of plants, delaying the onset of the main honey flow. Under such conditions, colonies that have already started swarming will remain in this state longer than usual. Unswarming colonies, regarded

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Mountain ash in bloom.



Umbelliferae—a source of the forest yield.



The horse chestnut in full bloom.



A migratory apiary on the red clover.

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to be more valuable, become overripe, as beekeepers say. Because there is no natural honey harvest, the flying reserves of bees remain unused, idle bees overcrowd the nest which becomes too stuffy, and frequently all this encourages the colonies to swarm. In either of these cases, the main honey flow is utilized only partially.

A hot spring is dangerous because it may sharpen the instinct for swarming in all strong colonies. To prevent swarming, one should timely enlarge the nest, improve its ventilation, and put the hives in the shade.

When the spring is long and cold, it is crucial to see that the nest has abundant reserves of honey and beebread.

These plants provide the main honey flow. Natural wood and shrub, as well as herbaceous plants and cultivated field crops may act as sources of the main honey flow.

Among natural nectar plants, of particular value are the yellow and white (or false) acacias, raspberry, linden, sweet chestnut, forbs of floodplain and mountain meadows, as well as those of dry waterless valleys, willowherb, heather. Among cultivated crops, the most precious nectar plants are white and alsike clover, sainfoin, melilot, coriander, buckwheat, sunflower, and cotton. Each of these representatives of the vegetable kingdom has its own phases of growth development, flowering, and fruiting. Nevertheless, in many of them, especially in herbaceous plants, these phases coincide in time.

Such nectar plants as raspberry, willowherb, buckwheat, and linden usually cover large areas and therefore each one of them can become the source of the main honey flow. The honey collected from any of these plants is monofloral (consisting only of raspberry, willowherb, linden, buckwheat, etc.). The longest to last (perhaps up to one month) is the honey harvest from melilot, willowherb, buckwheat and heather. The richest harvest is known to be gathered from willowherb (on freshly burned areas strong colonies may yield from this plant as much as 16 kg per day and even more), and from white acacia and linden.

The blossoming phase does not begin simultaneously in all nectar plants participating in the main honey flow. For example, in this country, the forbs in the meadows of the middle belt burst into bloom at the end of the first ten days of June, as a rule; linden – in early July, buckwheat – soon after the linden. Such alternated blooming of nectar plants provides either for one lengthy (overlapping) main honey flow, or for a number of independent flows.

Depending on the soil and climatic conditions, and also on the vegetation habitat, the time of blossoming may change for even one

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and the same nectar plant. In this way, plants of dry valley meadows bloom earlier and this period is shorter than is the case with the same plants in floodplain meadows. The time of plant growth and blossoming on the plains does not coincide with that in the hills. The time differences are as great as those in the altitude at which various nectar plants grow.

In this way, the honey flow from the same plants is a function not only of their specific features and amount, but also of their soil, climatic conditions, and the vegetation habitat.

It is crucial to know the onset of the main honey flow, so as to have one's colonies prepared and their maximum reserves ready for immediate honey harvesting.

The length of time that the nectar plant will blossom, which determines the type of honey flow, is usually fixed by the day when the first spring nectar or pollen plant bursts into bloom. It is true that, depending on the actual weather conditions, the growth phase in spring plants may become shorter or longer. Therefore, the onset of efflorescence in the main nectar plants may shift to either side and be accelerated or delayed sometimes by 10 days or even more. Most reliably, the potential onset of the main honey flow is determined by averaging the efflorescence data for many years. The time when one of the first nectar plants of early spring opens its flower buds should also be considered. For example, in the temperate zone of Russia, two and a half months pass from the onset of the pollen dispersion of the nut-tree until the blossoming of the small-leaved lime. In Central Asia, it takes 89 to 91 days from the blossoming of the star-of-Bethlehem until the flowering of the scurf-peas. The intervals between the efflorescence of spring and summer flora remain more or less constant. As a rule, the mistake in determining these intervals does not exceed two or three days.

The nectar plants participating in the main honey flow do not grow everywhere; each of them has by now settled in a quite definite microregion. Therefore the types of main honey harvests are not the same in all parts of this country. In the Far East, for instance, the main honey flow is composed of harvests from the Amur oak tree and Tartar maple, linden and summer-autumn forbs. In the central areas of the country, it is composed of honey flows from the forbs, linden and buckwheat; in Central Asia—from the scurf-pea, camel thorn, mountain forbs and cotton.

The sources of the main honey flow in spring are *the white and yellow acacias*. The yellow acacia (*Caragana arborescens* Lam.) is widespread over all of central Russia, the Urals, Siberia, and the Altai Mountains. It is especially abundant in the Altai Mountains where it

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grows in thick masses. In that area it begins blossoming in late May and finishes by mid-June. The honey flow from this species is annual and rich. Under favourable weather conditions, strong colonies may gather as much as 40 kg or even more. It is not without reason that the beekeepers of these regions regard the yellow acacia as the giant of nectar plants. Unfortunately, the honey flow from this tree is occasionally interrupted by returning cold days.

Large plantations of this valuable nectar plant occur in the shelter and roadside belts, parks and boulevards of the Central and poor in chernozem zones of Russia. The climate here is milder and the acacia honey harvest is stable.

The white acacia (*Robinia pseudoacacia* L.) is even richer in nectar. This tree is abundant in the forests of Moldavia, the Caucasus, the Kuban region, the south of the Ukraine, of European countries and those of South Asia. It is widely used as a decorative tree in urban and rural plantations, shelter and roadside belts. The nectar productivity of this plant is tremendous, up to one thousand kg per hectare (hectare = 2.471 acres). Its clusters are usually full of nectar, their wonderful tender smell making the surroundings fragrant for about two weeks. During this brief period, strong colonies can gather as much as 40 to 50 kg of splendid honey. With two honey flows from the acacia tree, which blossoms at different time in urban plantations and in natural forests, they may collect up to 70 kg.

Rumanian and Bulgarian apiarists consistently obtain two magazines of white acacia honey from every hive.

The vast forests in the piedmonts and mountains of the Caucasus and Crimea, the south and south-west of Europe are abundant in an excellent nectar plant, namely, *the chestnut sweet* (*Castanea sativa* L.). It usually blossoms in late June and, depending on the altitude of its habitat, its efflorescence may last for three to four weeks. The honey from this plant is dark and not very attractive in its appearance, but it is of high nutritional value and is very good for medical purposes. Its precious properties are due not only to the chemical composition of its nectar, but also to its abundance of pollen grains.

The chestnut is one of the richest sources of pollen, too. Bee colonies store it for a long time. And it is not accidental that beekeepers are always eager to take their bees to the mountains.

Of no less interest is the *horse chestnut* (*Aesculus hippocastanum* L.). It is a splendid decorative tree which greatly beautifies streets and squares in many cities and towns. The horse chestnut starts blossoming almost two months before the sweet one. The honey flow from this tree is quite good, the honey is light in colour.

This country is rich in the *linden* (*Tilia* L.) which is one of the main

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sources for commercial production of top-quality honey. Since ancient times, the linden honey has enjoyed the highest demands from customers and has been a major export item always beyond competition. Linden trees are first-class nectar plants. They are of great interest for present-day beekeeping too, both amateur and commercial. A hundred-year-old linden tree can yield over four buckets of nectar. The linden is proclaimed to be under state protection in this country, its cutting is outlawed or strictly limited.

The linden is the most important source of honey flow for apiarists in the central regions of Russia, the area near the Urals, along the Volga river, the Far East. In the leafy forests of these territories the linden greatly dominates over all other species and continuous thickets of linden trees cover thousands and thousands of hectares. Particularly rich in linden are the regions of the Upper and Middle Volga reaches and in Bashkiria, Tataria, Chuvashia, Mordovia, etc. In the Far East, the area inhabited by the linden embraces several million hectares, virtually covering all the numerous cone-shaped hills and creek valleys. Here, unlike any other place in this country, three types of lindens which are very different from one another coexist, namely, the small-leaved lime (*T. cordata* Mill.), the Amur linden (*T. amurensis* Kom.) and the Manchurian linden (*T. mandschurica* Rupr.). The first to blossom is the small-leaved lime (taketa) (late June-early July). Its honey flow just begins to decrease when still greater riches of nectar begin pouring from the Amur linden. The last blossom is the Manchurian linden which in these regions is called the queen of the nectar-bearing flora of the Far East. For twenty three to twenty five days the entire taiga is fragrant with the wonderful aroma of linden, whose flowers issue nectar as if from a rich spring. The most abundant in nectar is the Manchurian linden. Strong colonies may yield more than 32 kg per day from this tree. Totally, for the entire period of their blossoming, all types of lindens may produce up to 200 kg of nectar or even more. It is not accidental that beekeeping has become one of the most popular hobbies of the local population.

Such high honey harvests, unique in their duration, and above all, in their might, are due not only to the combination of the three different types of lindens growing here, but also to the local mild marine climate, the dissected relief of the locality and the high fertility of the soil. But yields of 50-60 kg of linden honey from each colony well prepared for such a rich honey flow in other parts of the country are also splendid.

The linden honey flow is very fast. The most abundant nectar secretion is observed in warm weather with an air temperature of 22 to 24°C. The slightly brownish flowers literally drop their fragrant,



During the main honey flow.



Bees are the main pollinators of gardens.



The tartar honeysuckle.

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The meadow crane's-bill.



The flower cluster of the sweet chestnut.



On the red clover.

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light-coloured juicy nectar, the aroma permeating the air with the wonderful smell.

In large cities, such as Moscow, Kazan, Saratov, Ulyanovsk, Gorky, there are quite a number of areas filled with linden trees in the streets and squares, and abundant linden parks and groves in the suburbs. Most of these trees are grown on very good soil and are cared for attentively (watering, feeding, undercutting). Thanks to these factors, the nectar secretion of these trees occurs virtually annually and is always very rich.

Urban linden trees are of particular value because they produce their honey flow some 10 to 14 days before the trees growing in forests do. Making use of migratory beekeeping, amateur apiarists can practically prolong the linden honey harvest from 12-14 to 24-26 days and yield twice as much honey as usual.

Since ancient times there has been and is another excellent source of honey flow, namely the *herbaceous flora* with its great variety of flower species. The most valuable among the latter are the white and alsike clover, lotus, tufted vetch, sage, speedwell, yellow lucerne, wild marjoram, geranium, cornflowers, cowparsnip, globe thistle, and other forbs. All these herbs, as a rule, blossom at the same time. Therefore the bees gather honey not from one of them but from several plants simultaneously. The honey collected from this great variety of forbs is called floral or polyfloral (or multifloral), i. e. obtained from different nectar plants. This honey has an excellent flavor and high medicinal properties.

The honey flow from forbs is usually average and in some localities even strong (up to 7 kg per day) and long, particularly in hard-to-get-to mountain and forest areas where these forbs remain unmown for long periods of time.

In this country, huge territories are covered by meadows. They are abundant in the north-west, in Central Russia, in the region near the Urals, and along the Volga River. Water meadows along the rivers Volga, Dnieper, Oka, Belaya and their tributaries are rich in pulses, umbelliferous and compositae families, which supply bees with plentiful nectar and pollen.

Of special significance in the nectar-bearing flora of Russia are the floodplain meadows along the powerful rivers of Siberia, such as the Enisei, Ob and Irtysh. Their left-bank floodplains stretch for over 50 and even 60 km in width; they are teeming with nectar-bearing herbs.

Siberian meadows are amazing not only for their tremendous variety of floral species, but also for their unique luxuriance and succulence. It is really surprising how all these wonderful plants can grow in such a severe region and within such an unusually brief time!

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The winter here lasts very long, for about seven months. Until late April the taiga is covered by a two-meter thick layer of snow, the frosts refuse to retreat, reappearing even in May. And it is as early as August that the first frosts of the coming winter occur. This weather is typical not for the extreme north but for the central and even southern parts of Siberia. However, as soon as the first spring breathing reaches these severe places, the local vegetation immediately wakes up. Hardly has the heavy snow managed to melt, when the buds on the plants begin to swell and start opening, the grasses begin growing and the willow family commences its flowering. One can imagine that at this time all members of the vegetable kingdom inhabiting this severe land are hurrying to make use of every fine day, so as to complete all stages of their development before the chilling frost comes back.

Nature itself has taken great care to help the plants in their speedy growth. It provides them with the heat and light so vital for their life, beginning with the very first days of May, but particularly in June and July. Within three months the local herbaceous flora passes through all stages of its development: in May and partially in June, it accumulates its vegetative weight, and beginning in the second half of June and throughout July it enjoys flowering. The nectar-bearing flora in the mountain meadows, both alpine and subalpine ones, is as rich in its diversity as a wonderful fairy tale. Very many top-quality nectar plants, such as mountain clover, wild marjoram, saussureia (*Saussurea latifolia* Ledeb.), can be found in these areas.

The honey flow from mountain forbs is strong and long. These qualities can be attributed primarily to the specific local relief. First to flower are the plants growing at the foot of the southern slopes which have abundant access to heat and light; then, in a terrace-like manner, the plants bloom higher and higher up. Those on the northern slopes blossom much later. While the species facing the afternoon sunshine are already in full bloom, the plants on the opposite side of the mountains are only approaching their budding stage. In addition, the northern slopes are abundant in such botanic species which are completely absent or very scarce on the southern ones.

Owing to the great variety of nectar plants and to the different times of their blossoming, their honey flow is not only strong and long, but also steady. This honey flow is of exceptional value because huge areas covered with nectar plants, due to their inaccessibility, remain unmown and even ungrazed annually.

The subalpine nectar forbs of the Caucasus are rich in Umbelliferae and Compositae. The upper green belt here is represented by alpine meadows which are so abundant in flowering plants that they are called the alpine carpet.

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The heather in bloom.



On the sowthistle.



Bees on the phacelia.



The willow in bloom.

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In full bloom in the willowherb—the main source of nectar in the taiga.



A flower cluster of the Norway maple.



The yellow acacia.



Rich in nectar is the meadow centauries, the borage, the coriander.

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All of these species are extremely valuable for the bees. Their blossoming is vigorous and their nectar secretion is stable. Such properties of these plants are greatly favoured by the mountains which protect them against the cold currents of air coming from the north, as well as from the arid south-eastern winds. The close vicinity of the Black and the Caspian Seas greatly benefits the local climate, making it mild and humid.

The high merits of the nectar-bearing flora in the Caucasus, as well as in the mountains of Altai and Tien Shan, lie not only in its rich variety of species, but also in their long flowering, determined by the unique local conditions which are particularly favourable for their growth. Most abundant in nectar plants are the alpine meadows in the Himalayas, Alps and Carpathians.

Among the richest herbaceous vegetation of forests one should specially mention such highly nectar-bearing plants as garden angelica, willowherb. Siberian beekeepers call them athlete-plants. In the north-western forests of this country, heather is the nectar-richest plant.

As to field nectar plants, the one which provides the largest honey flow is *buckwheat* (*Polygonum fagopyrum* L.). It has been famous for its nectar since ancient times. Buckwheat is cultivated practically everywhere. Areas containing this crop are especially vast in the Ukraine, Byelorussia, Central Russia, Kazakhstan. It is grown in Europe and even in the mountain regions of north-west India. In the northern areas of India, buckwheat may be encountered in its wild form, too.

The blossoming time of buckwheat depends upon the natural and climatic conditions of the zones. In Byelorussia, for instance, it begins blossoming in late June and finishes, depending on the sowing time, in mid-August. In fine weather, bee colonies can gather as much as 5 to 6 kg honey per day. In other zones, the buckwheat honey flow coincides with the end of the linden honey harvesting and actually continues after the latter ends.

The buckwheat blossoms long, for almost a month. Its secretion of nectar is the heaviest during its mass flowering which usually lasts for over two weeks. During this period, bee colonies bring in up to 4-5 kg of nectar per day. When sown several times, buckwheat yields a durable and guaranteed honey flow. It is not without reason that beekeepers say "Buckwheat is always a sure bet".

The buckwheat flowers secrete the largest quantity of nectar in the morning and therefore the bees, working on this plant, are most intensely engaged in their honey collecting only in the first half of the day.

Equally interesting for beekeepers is the *sunflower* (*Helianthus annuus* L.). The fields of this oil crop are literally unlimited in the

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Ukraine, Kuban, in the Central chernozem regions, in the area along the Volga river, in the Ural region, in Kazakhstan.

The sunflower is one of the last nectar plants of the season. It blossoms for one month, almost until the end of August. Its nectar secretion is high on rich chernozem soil when the air temperature is 25 to 30 °C. With higher humidity of soil and air, the nectar secretion is greater. There have been cases when bees collected as much as 8 to 10 kg honey from sunflowers. But, as a rule, the most stable honey flow from this crop is 3 to 4 kg.

New and high-yield strains of this crop have been recently introduced in this country. The role and significance of the sunflower in terms of its nectar- and pollen-bearing has been greatly increasing lately.

For most areas in Central Asia, the source of the main honey flow is the scurf-pea (*Psoralea drupacea* Bunge) which is a perennial pulse. It is most widespread in the south of Kazakhstan and in Uzbekistan. This plant blossoms in mid-May and blooms until late July. Its highest nectar secretion is observed on days when the air temperature is close to 30 °C. Good colonies can gather as much as 110 to 130 kg honey from this plant during its blossoming period. There is another plant that blossoms simultaneously with the scurf-pea, namely the camel thorn (*Alhagi camelorum* Fisch). It is one of the outstanding nectar plants of deserts and semideserts in Central and South Asia. The honey flow from the camel thorn is strong and lasts for 20 to 25 days.

Both of these species cover huge areas and grow in different localities. Each of them is a source of independent honey flows.

In May, the Asian nectar-bearing plants, growing in the forests along the floodplains of large rivers, become supplemented with another source of honey flow, i. e. the thickets of thornbush "chengil" [*Halimodendron halodendron* (Pall) Woff]. Good colonies may daily gather from this plant as much as 8 kg honey and even more. Its blossoming lasts about two weeks.

In the second week of June, forbs of meadows and steppes and those of the mountains, such as wild marjoram, sage, *Ziziphora*, melilot, blue fox, cornflower, dragon's head, thistle and others start to bloom. They provide a stable and medium-strong honey flow.

The most important source of the main honey flow in all republics of Soviet Central Asia is cotton (*Gossypium* L.), which is annually cultivated over huge territories. It is one of the oldest crops cultivated in India where it is known for over 2000 years. Beekeeping is noticed to be very attractive for the people living in cotton-cultivating areas. This crop blossoms from late June until late September. In the south-

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ernmost regions, its blossoming may involve some considerable part of October, too. The heaviest honey yields from this plant are obtained in July and August, when all representatives of this species are in maximum bloom. All of these nectar plants have adapted well to the conditions of Central Asia.

Beginning in May, the sun in these areas shines mercilessly. In summer the air temperature in the shade can remain at 40 °C or higher for very long periods, the soil temperature exceeds 70 °C. Autumn in these regions is usually also hot. Precipitation is mainly typical of winter alone.

The local vegetation has isolated itself in such places where it was more or less able to withstand the sun's heat. Some plant species occupied the valleys and floodplains of the rivers; others settled near oases and water springs. There were species which climbed high up into the mountains where the sun's effect is less dangerous because of the nearby snows. The valuable capability of obtaining moisture from the low soil layers has evolved in certain plants which penetrate with their roots down to 10-15 m deep.

Honeybees have also adapted their life to these conditions. They perform their honey flights most intensely during the coolest time of the day. At the hottest time of day, their flying obviously decreases.

Sources of the so-called *honeydew flow* are also of some practical value. Honeydew honey is very rich in sugars, microelements, acids and enzymes (qualities acquired via honeybees and orthopterous insects). It is highly appraised not so much for its palatability as for its excellent medicinal properties. Honeydew honey is particularly popular in Western Europe where it is always in great demand and is produced in large quantities. In Greece, honeydew honey comprises over half of all commercial honey gathered by bees; in Australia – up to 80%.

Honeydew is abundantly secreted by insect-parasites living on conifers, such as spruce, fir, pine, cedar; and also on deciduous species, such as oak, beech, linden, maple, aspen, white willow.

When the insects secreting honeydew multiply intensely (they are sometimes called the honeybees' allies), one hectare of spruce forest can yield as much as 700 kg honeydew, that of pines – up to 500 kg, oak groves – 350-400 kg. As N. M. Vitvitsky worded it, "honey-giving" aphides saved bees many a time in years with most severe droughts.

Enterprising beemen specially arrange their apiaries near the sources of honeydew to yield more honey. They have learned how to predict honeydew flows. They know how to determine the zones of maximally spread honeydew-insects, whose overwintered eggs serve

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as a marker, as do colonies of ants (in places inhabited by ants the secretion of honeydew is higher by 50-70%). All honeydew honey is always centrifuged after its harvesting.

The scouts report about the honey treasures they found. As soon as the plants start their abundant secretion of nectar and the scout bees inform their colony about the honey treasures they have discovered, all colonies get involved in the honey harvest.

Their instinct of food accumulation drives all activities of the colonies in the same direction – to gather as much honey as they can. But, in practice, bee colonies greatly differ in their productivity, because they are not all of similar qualities. Those which have preserved their working capacity and their might will gather much more honey than the colonies which lost their power during swarming.

Unswarming colonies quickly respond to the signals of their scouts, and very rapidly, literally within a few hours, switch all their reserves over to honey harvesting.

Swarming colonies, which have become greatly weakened after swarming and whose young generations are still too immature to work in the fields, begin their honey harvesting much more slowly and later. Their scout bees are too few and they fail to search for the sources of nectar as actively as the scouts in the unswarming colonies do, therefore their information is delayed and insufficient. In addition, they start their honey harvesting still later if their queen did not manage to mate before the onset of the honey flow. In this way, such a colony may lose several of the first days of good honey flow. But, finally, it will send more and more of its members to collect the honey with every subsequent hour.

This colony has no uncapped brood, its nest is already completed. Therefore it allows all of its bees capable of flying to plunge into honey harvesting. Every day the number of honey-collecting bees increases, owing to the newly born generations. The energy of their flight is very high: all of the bees are young, strong, they have not yet taken part in any of the colony's jobs.

However, the colony's stores of food are not ample. The old stocks of food were spent by the maternal colony for its own needs and for growth and development of its offspring. Governed by its instincts of reproduction and swarming, the colony could not procure new stores of food for its future. In addition, some part of the honey it had was taken away by the swarm. Under these conditions, the colony may perish from starvation if it fails to provide itself with sufficient stores of food in time. The colony instinctively feels the danger and therefore all its energy and all its efforts are now aimed at honey harvesting.

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As to the swarm, nature simultaneously augments two of its instincts, namely, for building and for honey collection. Having settled in its new home, the swarm in the very first minutes seems to be divided into two parts. The larger one immediately starts building the nest, the second concentrates on gathering the food, because without food stores, likewise without its nest, the swarm would simply be doomed to die.

As soon as the nest is laid in its foundation, the mason bees also switch their energy for collecting the honey. Now their honey-gathering instinct becomes the leading one, governing the life of the colony.

The bees of the swarm spare no effort or energy for their honey harvesting. And this is quite logical: their newly built nest has no food yet, and there is nobody to prepare it for them if they do not do it themselves.

The bees try to store as much honey as they can also because when the brood appears, the colony will have to reduce its ranks of old flying members which will be needed for brood rearing.

The swarm, leaving the nest on the eve or at the onset of the main honey flow, under good weather conditions gathers more honey than it uses for its daily food.

It is better to have an extra magazine than to be short of one comb. The bees bring to the hive the nectar which is frequently liquid, containing up to 70-80% water. To transform this sugar juice into honey, they spray it over as many combs as they can, so that the empty cells are filled, at most, to one fourth of their volume. Then the water inside the combs will evaporate faster.

When the hive is short of combs, the bees have to fill the cells to their top. Rather often, they even store their nectar in cells with almost ready honey and thus they have to spend more efforts to process it again.

It is believed that with a honey harvest of 3 kg per day, the colony needs a whole storey of a multiple-storey hive or one magazine in the Dadant-Blatt hive. Bearing in mind that the nectar brought to the hive turns into real honey no earlier than in seven days, and that within that whole period the bees continue collecting new kilograms of nectar, the beekeeper will need ever increasing areas of combs to accommodate all the honey in the hive.

As seen from practice, it is better to have one extra magazine in the hive during any honey flow than to be short of a single empty comb. Feeling the shortage of space in their hive, the bees reduce their flight energy. In some cases they even leave the hive and begin building new combs outside, beneath the hive's bottom.

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During linden honey flows, colonies need as many empty combs as they already have in their nests. Colonies living in three storeys receive three storeys with empty combs, i. e. the hive volume is doubled. If the weather conditions are particularly favourable for honey collection, the beekeeper may even have to install additional magazines.

During the main honey harvest, especially when it is long, the bees eat very well and secrete a lot of wax. At this time they are eager to build combs. To make proper use of this valuable building material and of the mason bees' energy, the hives are supplied with frames of foundation sheets from time to time. The latter must be in such quantities so as not to divert too many bees from their honey gathering, otherwise they could all start comb constructing. It is believed that one nest frame or two magazine frames with foundation do not adversely affect the bees' flying activity, but, on the contrary, allow the beekeeper to obtain many new combs.

It was found that with excessive comb building, when the hives receive a whole storey or a whole magazine with foundation, colonies gather at least twice as little honey as compared with those which are not engaged in such huge construction jobs.

Foundation frames are usually given to colonies each time that their hive is supplemented with a new storey or a new magazine.

It is better if magazines and storeys to accommodate new honey are made of light-coloured combs which have not been used for brooding. Then the honey will preserve its natural flavour, taste and aroma.

If the beekeeper is short of combs, he may compose his magazines for new honey by using brown combs, too, even dark ones, if necessary. But dark combs are used to obtain honey by the centrifugal force. By the way, bees lay their honey in dark combs as eagerly as in the freshly built ones.

Dark combs used for brood rearing, or magazine combs which have become dark with time, being still sufficiently strong, can be easily transported. They also withstand the centrifugal force when honey is separated from them well. Drone combs can also be employed for honey accommodation. During the main honey flow, queens do not lay eggs in drone cells. In view of this, many beekeepers in this country and abroad specially equip magazine frames with drone foundation. These combs are more capacious. Their honey is extremely tender, particularly when stored in freshly built combs sealed with snow-white caps. This honey utterly retains its natural taste, colour and aroma; it is always in great demand. The same quality is observed in honey accommodated in magazine combs with bee cells, when eight, and not ten, frames are installed in the magazine

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added to a multiple-storey hive, and nine or ten frames in the hive of the Dadant type. Thick combs can contain more honey and are easier to uncap.

During the honey harvest, especially when it is intense, each comb is as precious as gold.

If a beekeeper is short of combs, he has, naturally, to extract honey from the hive several times during the honey flow, especially when the flow is strong and rapid. Some people claim that such practice is quite justified. They believe that a honey-poor nest compels the bees to gather more nectar. Therefore they prefer to remove the honey from their hives practically almost every second day. It is true that the colony augments its activity when deprived of its honey stores, which is quite reasonable. During the main honey flow the colony is in a hurry to procure its food; moreover so, if, despite all its hard work, the quantity of honey is not increasing but decreasing, and on their way the bees constantly encounter empty combs. However, the practice of frequent honey removal is faulty. It results in production of low-quality honey (unripe and quick to spoil) and, in addition, it violates the working rhythm of the colony and reduces its productivity.

When their honey is extracted in the morning or afternoon, the disturbed colonies bring almost half as little nectar as they usually can. If this operation interrupts the bees' work in the late hours of the day, they will "undergather" about the same quantity of honey on the next day. Above all, frequent honey removal involves huge labour expenses.

"One thinks that bees become more lazy when well fed...," wrote N. M. Vitvitsky, "reveals a lack of knowledge about bees' nature. Abundant honey stores in hives have so far never led to any adverse consequences, while their shortage always has."

Advanced beekeepers in this country and abroad make use of another technique to activate the flying capacity of bees. This technique is genuinely progressive and fruitful. Following it, beekeepers steadily provide large numbers of empty combs above their bees' nests. These empty combs act as stimuli to which the colony responds by its active honey flight.

Bees have an extremely valuable biological property which attracted man and initiated his interest in beekeeping. They gather honey to store it as long as nectar plants secrete it and the hive has sufficient room to accommodate it. By this act nature has precluded any possibility for the bees' death from starvation. The instinct of food accumulation governs the colony to such an extent that, when its hive is short of empty combs, it seems to be ready for self-destruction. The bees start pouring honey in literally every cell free from brood; in

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this way they completely prevent their queen from doing her normal work. There are many cases when, during a strong and prolonged honey flow, a colony frees itself of brood and the bees fill all the combs with honey, and in doing so they become totally exhausted by the beginning of autumn. Such colonies, which were previously very strong, must be reinforced with bees from other colonies or they will perish.

Hence, no matter how much honey the hive has, its quantity does not reduce the flying activity of the bees, which is determined not by the lack of honey in the nest but by the abundance of nectar in nature, as well as by the quantity of empty combs necessary for its accommodation. This is one of the most important conditions for the maximum exploitation of the main honey flow.

If a beekeeper underestimates the role of combs during the main honey flow, he may lose at least half of his honey harvest. Experienced beekeepers accumulate large quantities of combs to supply to their bees when necessary. They withdraw honey from the hives only at the end of each main honey flow, and only when it is ripe.

The methods which will ensure the most complete use of the honey are determined with regard to the onset time and pattern of the main honey flow (its strength and duration). Some of these techniques permit the colonies to maintain their hectic working rhythm and prevent their passivity; others increase the colonies' flying reserves. Using other methods, beekeepers provide their colonies with so much space in their hives and with so many combs that they can store any amount of nectar without being distracted from its collection, which is their primary and immediate duty.

During the main honey flow, the bees collect not only nectar but pollen, too. The latter is vital for brood rearing. It was believed in the past that pollen harvesting competes with honey harvesting, but this is not true.

The apiary is put on wheels and moved nearer to the sources of nectar. No matter how rich in nectar-bearing areas one's apiary is, in most cases there is still not enough nectar and pollen to last throughout the spring, summer and autumn seasons. A settlement may be famous for its thickets of willows and numerous orchards and gardens, but it may lack the true sources of the main honey flow if the nearby lands are covered with grain, cultivated and other crops which do not secrete nectar.

Some other locality may have no or very scarce nectar-bearing spring flora, but has a wonderful linden park or linden grove which can supply bees with plenty of honey.

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There are such places that are rich in willow trees, in gardens and orchards, meadows and linden forests, but all of these may be small, or even in large numbers, but still insufficient, and they cannot provide all the bees living in the vicinity with the abundant quantities of nectar that they need. Sometimes large areas with extremely valuable nectar plants, for example, buckwheat, sunflower or sainfoin, are situated too far from the nearest settlement and the bees simply cannot reach them.

There are frequent cases when a nectar plant, which was the focus of one's hope, suddenly fails to meet one's expectations: its blossoming coincides with very hot, or on the contrary, very rainy weather which is not conducive to the bees' flying. As a result, the apiaries remain honeyless, though just a few kilometers off one nectar plant has stopped flowering, while another is just beginning to bloom. The latter, being a later source of the main honey flow, may bring much honey if one moves his bees closer to it.

Such transportation of bees from one honey source to another is called migration. Perhaps, the first time man took some wild bees from the forest and transported them together with their nest to his home (for more convenient maintenance and protection), it occurred to him that he could travel (migrate) with them from some nectar plants to others. It is quite possible that a folk saying of great wisdom was born in those old times. It says: "One must go where the honey is!". And present-day beekeepers who travel with their apiaries by car, covering hundreds of miles, joke when asserting that "the best food for bees is petroleum". "It is not the bees that look for honey now but the beekeepers."

Migratory beekeeping is a tremendous apicultural achievement. It permits gathering nectar where its quantities are the largest; consequently, one can get rid of "windows without honey flow" and to some extent become independent of the environment.

Migratory beekeeping is a very old technique in apiculture. It was widely used by all nations of the world, especially by the Slavs. With the advance of cultivated farming, the forests, which were so rich on the lands of the Slavs, were pushed off from the settlements. The fields were widely sown with entomophilous crops (legumes, cereals, oil plants). The beekeepers of those times began to move their bees more frequently and in larger quantities as close to these plants as possible, so as to pollinate these plants and to yield honey from them.

Apiaries are transported not only to the sources of the main honey flow, but also to such nectar plants which are of secondary importance but help intensify young-bee rearing for the main honey flow, or provide for the bees' better preparation for winter. In this way, the

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beekeepers in the Kuban area travel with their bees in early spring to the river floodplains covered with thick forests, to the shrubs and woods of the piedmonts and mountains of the Caucasus mountain range. After the colonies accumulate there considerable quantities of bees and brood and replenish their stores of food, the beekeepers bring them back to the settlements where they will gather the honey flow from the white acacia and honey locust. In the Far East, having harvested the honey from the taiga linden, beekeepers take their bees to the forest-steppe to gather the honey flow from the lespedeza and from late forbs. If colonies are weakened after their linden-honey gathering, they can usually well restore their strength in the forest-steppe and raise many young bees for the coming winter. Under favourable conditions, they can even collect a lot of commercial honey. Many beekeepers in the Moscow region travel with their bees to glades closer to the raspberry thickets in spring, and in summer – to the meadow forbs along the river floodplains, or to urban linden plantations, and then to the buckwheat fields in the nearby territories.

The nectar-bearing vegetation of many towns, cities and settlements is of great value for amateur beekeeping. Numerous squares, avenues, and streets in towns and cities are traditionally planted with the linden, chestnut, white acacia, honey locust. Urban parks, boulevards, public gardens and gardens are almost exclusively planted with the linden and Norway maple. There are also many trees of yellow acacia, Tartar honeysuckle and a great variety of decorative nectar shrubs. The willow family is abundantly represented on the banks of urban ponds and water reservoirs.

In Moscow, for example, and in its green zone there are about 100 000 hectares planted with the most diversified nectar-bearing trees and bushes. This treasure of nectar is skillfully exploited by the beekeepers of the capital and its suburbs. The beekeepers of the Riga area also utilize well the honey flow from the linden. They bring to Riga as many as two thousand hives annually and gather as much as 30 to 40, and in some years even 50 kg honey from each colony.

There are many nature lovers who keep bees in Kiev, Kuibyshev, Voronezh, Frunze and other large cities. In spring and summer, hundreds of beekeepers from the suburban zones travel to these places with their bees to gather honey flows from the shrub and wood vegetation. Such migratory apiaries can bring three or four honey yields per year.

If a beekeeper has travelled with his apiary to a honey-harvesting area at least once, he has definitely appreciated the great advantages of this technique over the stationary ones. After that he will become a travelling beekeeper and will never miss the chance to gather honey

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Bees are equally fond of cornflower, too.



Golden blankets of coltsfoot.



Honey-bearing forbs (nectar-bearing forbs).

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The inden is justly called the queen of nectar plants.



Pollen-bearing Rosaceal and nectar-bearing forest raspberry.

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flows somewhere nearby. Unfortunately, too many beekeepers do not travel with their bees. Some of them find it difficult to prepare their bees for transportation, or regard the very transportation dangerous for their bees and are afraid they may perish en route; others are too busy with their full-time jobs to spare time for such travels; there are people who cannot tolerate the inconveniences of "life on the road". Some of these reasons may be genuinely sound, but not to such an extent that one should, of his own free will, pass up the chance to get an additional 30 or 40 kg honey, and frequently even more, which migratory apiaries obtain from every hive.

To prepare one's bees for transportation is not very difficult, especially when all the hives are equipped properly beforehand. Furthermore, there are no great difficulties in protecting the bees in the forest or field, if the travelling amateur beekeepers cooperate and take turns guarding the bees.

With this kind of organized bee migration, beekeepers can more easily include their beekeeping in their everyday activities. In just an association, no matter how small, based on a common interest nobody will feel lonely. Their constant contacts will enrich one another's experience and knowledge. And since such groups unite persons of similar outlook, their time together in nature will be especially pleasurable and memorable. Frequently large farms, having vast areas of cultivated nectar plants, do their best to encourage such small groups of travelling beekeepers. They are interested in having their plantations pollinated by bees, especially those whose apiaries are not rich enough.

Travelling beekeeping is one of the best forms of active recreation. It is particularly nice in summer time. One can fully enjoy the warm nights, rich in the aroma of flowers and fresh honey. Furthermore, it is a time when forest berries, nuts, and mushrooms are abundant; a time when the fish in the rivers bite especially greedily. Isn't it a real pleasure to spend the vacation together with your bees amongst the incomparable beauties of nature and its wonderful gifts?

Before preparing bees for transportation, one must look for an appropriate area covered by a nectar-rich plant and verify the length of time that the plant blooms.

If one finds two plots with equally good sources of nectar, preference should be given to that of higher soil fertility (for example, when growing on sandy loams, the linden bursts into full bloom but virtually does not secrete any nectar; while growing on clay, and especially on black soil, it yields plenty of nectar almost every year), or of non-uniform relief. In both cases, the blossoming time will be longer, making the honey flow more stable.

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As beekeepers say, when in the thickets of willowherb, one must look for willowherb. Growing on peat bogs, it does not secrete much nectar, but on freshly burned areas its nectar yields are very high.

If one area under a commercial nectar plant is in an open field, moreover on an elevated hill, and the other is situated on a plain and close to a forest, a forest belt, or a small river, the choice should be made in favour of the latter. Its microclimate is softer, conducive to the secretion of nectar in the plants and also to the work of the bees.

It is not desirable to locate one's apiaries close to large bodies of water, especially when the sources of the main honey flow are situated on their opposite bank. One will inevitably lose many of his flying bees if these factors are neglected.

The amount of precipitation within the period of nectar-plant vegetation should also be taken into account. Rains frequently fall in strips, embracing only some part of the region, while the rest of it remains thirsty for moisture. Nectar secretion by plants will be much more intense in areas which have just recently enjoyed heavy rains, since their soil still retains good stores of water.

Rather frequently, beekeepers travel from a nectar plant sown early to the same type of plant but which is sown later. Thus, the honey flow is prolonged and one's chances to yield more honey from this plant greatly increase.

It is highly desirable that next to the source of the main honey flow, or at least nearby, there are plants providing secondary nectar flows. In case the main nectar plant is not strong enough or its secretion lasts not the whole day but only for a few hours, which is typical of buckwheat, for instance, the bees will be able to work on nectar plants of secondary importance.

The inbred qualities of one's bees are also very essential. Bees of the Middle-Russian breed are versatile in their properties. They can work effectively on most nectar plants, but particularly well on the raspberry, willowherb, linden, buckwheat, heather, and forbs. Bees of the Carniolan breed prefer to visit the buckwheat and herbaceous flora. The gray Caucasian bees, on the contrary, avoid the buckwheat and gather honey mainly from forbs and the sunflower.

It is always useful to consult the local beekeepers and agronomists and to learn from them about the nectar-productivity of the local natural and cultivated fields of nectar plants, the condition of the nectar-bearing vegetation and soil. One should know that different strains of buckwheat and sunflower differ in their nectar content.

To know well the qualities of the local nectar-bearing flora and to be able to predict the expected honey flow is a most important factor determining the final outcome of the entire apicultural season.

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When a beekeeper decides to travel with his hives to cultivated nectar plants (buckwheat, sunflower, coriander, etc.), he must ask the permission of the farm management to accommodate his hives on their land and official grounds. To use buckwheat honey, the bees should be brought to its fields at the early stage of budding, because this nectar plant secretes its valuable liquid most abundantly within the first two weeks of its flowering.

If the beekeeper wants to take his bees to a forest, he must address the local forestry authorities. The latter will also allocate the places for accommodating the apiaries. Such places are usually fixed on an open glade or in the forest skirt, near or among the nectar-bearing areas. The plot chosen should be dry, well heated by the sun, its vegetation should protect the hives against the sunshine during the hot morning hours.

Near such strong nectar plants as the linden or white acacia, and frequently near cultivated nectar crops, often as many as 100 to 150 colonies are placed. Under such crowded conditions, there are so many bees that the quantity of nectar secreted by these plants is frequently insufficient for all of these bees, and very often runs out before the working day is over. To gather one of their honey loads, bees under such conditions spend much more time than it usually takes them when they are in their natural, ordinary environment, where nature does not permit even the slightest overcrowdness. That is why on large apiaries the bees are usually irritated during the main honey flow, while one never observes this on small apiaries.

Taking into account this aspect of bees' nature, large apiaries have lately been reduced in size, and not only those near nectar plants of weak or average nectar secretion, but also near those which yield high amounts of honey.

It is most rational to arrange one's hives in groups of 20 or 30 colonies but never more than 50. Thanks to such minimizing of the apiary area, productivity can be greatly increased. *The temporary division of apiaries into smaller units is a most successful technique for utilizing honey-yielding areas to their utmost.*

When travelling with his bees to cultivated nectar-bearing crops, the hives should be as close as possible to the plants, using shelter belts whenever possible.

The apiaries are arranged on the opposite sides of the field, or in its middle if it can be reached by a road, so that the plants can be pollinated better and their nectar can be utilized fully. One must see that his apiary is never located in the path of the bees flying from another apiary.

In two-queen beekeeping, the hives are arranged in pairs. Nuclei

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are usually installed close to the main colonies. Such practice helps the beekeeper to reinforce his colonies with the bees or with brood from the nuclei.

Shortly before one transports his bees to a distant apiary, one should examine thoroughly all the roads leading to that place and improve them if they are in poor condition or inconvenient; one should also prepare the very place which will accommodate the hives, and the tent or the panelboard house in which he will live.

Sometimes it is impossible to settle the apiary in the close vicinity of the natural nectar vegetation because there are no proper roads to get there. In such cases, the migratory apiary is arranged in such a place so that the nectar-bearing area is within the bees' productive flight range.

Forest plots allocated for apiaries are protected by law against wood-cutting and shrub-cutting; it is forbidden to construct any buildings (timber houses, winter huts, etc.) there, amateur vegetable gardens, and so on. Such plots are allocated only for seasonal use. In short, each travelling beekeeper must follow strictly all instructions of the forestry authorities.

Colonies in 12-frame and in long hives are prepared for transportation in the following way. When the bees are in flight, the hives are opened and the frames with sealed honey are removed if they are more than half-filled, especially if the honey is stored in freshly built combs. This is done since these heavy combs may get broken off during transportation (especially if the roads are poor) and thus kill the bees, and often even the queens. Combs containing large quantities of liquid honey are also withdrawn. They are replaced by frames with empty combs.

In nests which have frames without permanent lateral partitions, temporary ones are installed near the back and front walls of the hive to separate the frames. V-shaped partitions are arranged between the last frame and the lateral wall of the hive to press the frames together.

Colonies' nests in multiple-storey hives are not prepared for transportation in any special way. In such hives the combs are shorter than in those of the Dadant type by 70 mm, therefore they are lighter in weight and sturdy. To transport such combs with their liquid honey is not dangerous because the water vapours, forming en route in this taller than broad bees' home, exit from the nest through the net or roof attached to it. Frames with permanent partitions cannot be moved. Only the honey magazines can be removed.

In summer colonies become strong and their nests contain much brood. Therefore, to transport the bees, one installs in his hives some magazines which are either empty or contain empty combs, and above

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them special bee nets are arranged. Such nets can protect the colonies from death due to excess water vapours. All flight entrances are firmly secured beforehand.

Nets for migratory hives are made either specially or they may be assembled in the hive roof. In Rumania, this net is made in a different way. Rods which are equal in length to the external length of the roof are attached to the sides of an ordinary net. At their ends the rods have special notches, 20 mm high, to support the roof and to provide for a ventilation chink, 30 mm high, through which normal air exchange can be guaranteed in the hive during its transportation in the daytime and at night.

When en route, especially along poor forest or mountain side roads, the bees get excited. Their excitement increases if they cannot leave the hotter part of the nest, containing the brood, for a cooler one or go outside the nest.

Bees cannot tolerate any isolation from the outside world. Under natural conditions they can leave their nest at any time they want, both during the day and at night.

When the hive is transported, its internal temperature rises much above the optimal, especially when the air supply to the hive is limited or ceases completely (this may happen if the flight entrances are firmly secured and the upper ventilation is insufficient). In addition, if the nest still has some light honey, or the bees, disturbed by the preparations for their transportation, have filled their honey sacs with liquid honey, the air in the hive gets oversaturated with moisture and carbon dioxide; its oxygen content decreases with every minute. Under such conditions the bees are most excited.

As is known, bees reduce their body temperature by evaporating water through their respiratory system. When the ventilation in the hive is poor and the concentration of carbon dioxide is excessive, the respiratory organs in the bees (tracheas) become overfilled with water vapours. Then, within some brief five or seven minutes, the entire colony may perish from excess water vapours. The bees look as if they have been scalded with boiling water. To prevent such an oxygen deficiency and scalding of bees, their nest must be well provided with fresh air and nothing should block its supply to the hive.

When hives are equipped with ventilation devices in their roofs, no magazines are installed in them. The bees can move from the nest upward, to beneath the hive roof where fresh air regularly arrives. The slit between the hive walls and the roof framework should be narrow enough so that the bees cannot get out.

There are cases when the bees are transported in hives with their flight entrances wide-open. Moving nets are not used in such kind of

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Poppies are excellent pollen-bearing plants.



The hawthorn yield both nectar and pollen.



The sweat clover secretes lots food even in arid summer.



A migratory apiary in the mountains.



On a house-attached plot.

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bee-transportation. Disturbed by their transportation, the bees can now leave their hive (they usually gather on its front wall), and therefore the nest temperature does not rise above the optimal level. When the car moves, the ventilation inside the hive increases since the flight entrances are open; the disturbed bees gradually return to their nest, and the colony by-and-by calms down.

Not to lose the bees during this drive, the hives, together with the transportation vehicle, are covered with a thick caprone net. This method of transporting bees has become particularly popular in the USA.

The only disadvantage in transporting the bees in hives with their entrances opened is that the manual loading and unloading of the hives is inconvenient.

The hive is regarded ready for loading after all of its disassembled parts are firmly fixed in place. The clamps used by beekeepers to secure their hives are of different designs; they can be bands, cables, locks and other types.

As a rule, one begins loading the hives in the evening, after the bees terminate their flights. If the beekeeper plans to transport his hives with their flight entrances open, he should jet one or two puffs of smoke inside them before loading. The bees will take honey into their honey-sacs and will behave more quietly.

When transported along good and asphalt-paved roads, the bees are not greatly disturbed. The arrangement of hives inside the car is not very important, but it is always better to arrange them so that their front and back walls correspond to the front and back of the car. Then the inertia force, induced by rapid driving, will affect not the planes of the combs but their lateral faces, and the combs, even the heavy ones, will not break up.

In transporting the bees along forest or side roads which are bad and compel all vehicles to move slowly because of their uneven contours, the hives must be arranged in the car so that their combs are at right angles to the car's motion. In such a position they will better withstand the forces induced by the sharp rolling oscillations.

The loading is conducted beginning from the driver's cabin, the side and tail flaps of the vehicle being lowered beforehand. The hives are arranged with their back walls up against the front side of the car.

All magazines with spare combs, hive stands, all beekeeping equipment, the fettled smoker, all personal belongings, the tent and food-stuffs are loaded in a separate car, or near the tail gate of one of the cars carrying the bees.

When the beekeepers combine their hives for transportation, they arrange them in the car in two or three rows, one above another.

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Hives of the same size and type are usually installed in the lower row, the rest – on top of them.

Strong colonies in multiple-storey hives can be well transported in three storeys in summer, and in two storeys – in spring and autumn. If the hives are transported without their roofs, some rods are assembled above the moving nets, or a frame is made of such rods to support the hives of the next row on its top. With this arrangement, the hives are constantly supplied with fresh air. When transporting hives of the same type and with flat roofs, the upper rows of hives are immediately installed on the roofs of the lower ones. The hives are firmly tied up with ropes and the caravan starts on its trip.

The speed of the car carrying the bees depends on the quality of the road: on asphalt-paved roads, it is the same as with all other kinds of cargoes; when on side roads, one must always take into account the contours. To avoid sharp jerks on large pot holes, where heavy combs may break off, the speed must be reduced.

Upon arrival to the area of nectar plants (it is most desirable to be there before sunrise), the beekeeper immediately sets the hives up at a maximum distance of 3 or 4 m from one another. If there is no source of running water nearby, a drinking bowl is installed somewhere close to the apiary.

If the caravan arrives at its destination late at night, the beekeeper opens the flight entrances in all the hives. The bee colonies, especially those which are very excited, will calm down sooner. When the caravan arrives at dawn or at sunrise, the entrances in every second hive are opened, and primarily in those with strong colonies. If all bees from all hives start flying around simultaneously, it will inevitably result in an extremely stormy orientation flight, and many bees from certain colonies will settle in hives of other colonies. Most frequently, the bees will fly to the strongest colonies. Then, some colonies will become still more powerful, while others will get weaker.

After the colonies which were the first to fly around finish their flights, the beekeeper opens the entrances in the other hives. If the bees notice any leakage of honey from a hive, they will not go flying or their orientation flight will be very weak. This colony must be carefully examined and immediately assisted. The frames with the broken combs are removed and replaced by new ones containing empty combs or foundation. The bottom covered with the spilled honey is replaced by a clean one.

In the evening or on the next day, when the bees have completely calmed down and start gathering honey, the colonies' nests in long hives receive frames with honey and beebread. The frames are installed closer to the hive's edge. They were selected when the bee-

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keeper was preparing for his bee-transportation. The bees will preserve the beebread by filling it with honey and sealing it. The upper rods of the frames are marked in coloured pencil with the word "beebread". To collect the honey from the hives, one installs on their tops special magazines or storeys previously filled with frames of foundation or of empty combs (they are arranged on the sides) and some combs containing honey and beebread (two or three in the middle).

Travelling beekeepers often cover great distances, sometimes hundreds of kilometers. To reach such far-away places within one short summer night is simply impossible, and therefore the caravan goes on moving during the daytime, too. When the car moves fast, the hives can be well ventilated and there is no danger of bees' overheating or scalding.

When the weather is cool or stormy, the bees can be transported during any time of the day. Roofless hives are covered with tarpaulin to protect them in case of rain. In the tail corners of the car, one fixes two rods which exceed the height of the upper rows of hive by one meter. The tarpaulin is stretched and its two back corners are tied to these rods, while its other two corners are firmly attached to the front corners of the car body. The tent so made can well protect the bees against any rain, so that the beekeeper may continue his trip even in bad weather. If the tarpaulin slopes towards the tail gate of the car, it may be torn off by the wind, and then the rain drops will fall on the hives.

Before one returns from his migratory apiary or moves to another area of nectar plants, all the magazines with honey are removed from the hives and transported separately. The combs are not removed from the nest.

European beekeepers use extensively mobile pavilions containing 30 to 40 hives. The bees in such pavilions are always ready to be transported.

To help the bee colonies located near the nectar plants to work to full capacity, one must see that the bees can allocate their reserves freely, so as to be as active as possible.

Only strong colonies can gather a lot of honey. According to C. Farrar, four colonies of 15 000 bees each will yield 100 pounds honey, while one colony of 60 000 bees can produce over 150 pounds. *As the colony's power increases, so does the honey yield.* It was G. P. Kandratiev who pointed out long ago: "Our entire salvation is in strong colonies."

Taking into consideration the sources which will provide the honey, one estimates the number of magazines and combs necessary for its accommodation.

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At the onset of honey flows from forbs, it is sufficient to have one magazine on each hive; new magazines will be added as the honey flow increases and the first magazine gets filled with honey. In hives of the mountain or Italian bees, the magazines are installed on top of those already filled up; if the hives contain bees of the Middle-Russian breed, the new magazines are arranged under the filled ones.

When the main honey flow is not strong, to prevent the queen's penetration into the honey storeys, the nest's combs are covered with a screen board. The board is not used if there are magazines in the hive. The queen does not work in magazines with widely set frames, and the bees can gradually fill them with honey. As a rule, beekeepers in commercial farms of the USA, Canada, Australia, Rumania, as well as many beekeepers working with multiple-storey hives in this country, employ magazines to accommodate new honey. Such magazines are easier to operate, they can be filled sooner with honey, and the bees do not get stuck there when one applies carbolic acid or other chemicals to repel the insects when removing the honey. Magazine combs can be easily transported, they are practically everlasting, because they are almost never attacked by the wax moth which feeds not so much on the bee wax but rather on the protein substances contained in the bee pupae. And the latter are not to be found in the combs.

To be able to utilize best the alternating honey flows of poorer might, it is sufficient to have two or three magazines per each 12-frame hive and one magazine per each long hive; a multiple-storey hive requires two storeys in addition to those with the brood, or three or four magazines.

Many more combs will be required if the honey flow is long and begins from several sources at one time (from forbs, linden and buckwheat), or is heavy from the linden alone.

After the honey flow from the meadow is over, the magazines filled with honey are removed. If there are no vacant combs to accommodate the linden-honey flow, the honey from the forbs is centrifuged. If there are a sufficient number of available vacant combs, it is better not to extract the meadow honey at once, because it may be of use later if the subsequent honey harvests prove to be poor and the beekeeper has to return it to the bees' nests.

The number of storeys or magazines containing empty combs may be twice as great, at least during the linden-honey flow, as that during the honey flow from meadow forbs. The best time to provide these magazines is not during the honey harvesting, as is done most often, but before it begins or at its earliest onset. There are no grounds to fear that an extra magazine excessively increases the hive volume: the colonies at this time are very strong, the weather is warm, and some

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extra vacant space inside the hives will only benefit the bees' work. These extra magazines are necessary not only for storing honey, but also for scattering the bees. The added magazines will house the young bees which work on fermenting the honey. A proper dispersal of bees inside the hive improves the medium in the brooding zone and thus precludes one reason for swarming. It was noticed that empty combs situated above the brooding part of the nest activate the bees' flight activity.

The high energy of bees' flights can also be conditioned by a good and steady air exchange in the hive. The rate of air withdrawal from the nest during a strong honey flow may be as high as 70 meters per minute. Since there is no danger that alien bees may attack the hives, the lower and upper entrances in the brooding storeys are opened as wide as possible. One can augment the ventilation in the hive by rearranging the upper storeys to form slits of 10 to 20 mm.

Honeybees are known to possess the wonderful property of thermoregulation, in other words, they can maintain an optimal air temperature in their nest during any time of the year, be it winter or summer, during their brood-rearing or when there is no brood at all, even if the temperature outside the nest is below freezing or fluctuates greatly. However, it appears that it is much easier for bees to raise the temperature by 15 or 20 °C than to reduce it by 2-3 °C, should it begin to exceed the optimal nest temperature due to the environmental conditions.

It is known that in hot weather, especially in southern regions, the air temperature during the summer honey flows is usually higher by 5 or 7 °C, and occasionally even more, than that in the hive. Under such conditions, many of the bees who would normally work in the fields must remain in their nest and work on its ventilation. Huge numbers of bees, their abdomens up in the air, stretch out on the flight board, at the bottom of the hive and on the walls inside, in various parts and corners of the nest, as if "switching on" the ventilators: they energetically vibrating their wings to ventilate their home. This is a very tiresome job, and the bees already tired must be steadily replaced by new ones.

The ventilation in the bees' nest is vital not only for decreasing its temperature but also for evaporating the water from the nectar, for supplying oxygen to the eggs, larvae and pupae. As we can see, the bees need their nests to be well ventilated and such ventilation is provided artificially.

It is better to keep bees in multiple-storey hives. The very fact that such hives are composed of several storeys or magazines arranged one upon another, most frequently five or six of them, facilitates the con-

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ditions for the bees' life. If the beekeeper shifts slightly the uppermost storey from this tall hive, a slit will form through which, like through a tube, the air currents from below will rush in, and thus the microclimate in the nest will be improved. And at once the number of bees engaged in ventilating the nest will diminish considerably. In long hives with horizontal nests such a good air exchange is not attainable.

The hives are usually placed in the shade of the nectar plants on the northern slope of the mountains, and as close as possible to the water sources, since water significantly reduces the effect of the heat and, which is more important, permits the bees to supply their nests with water (it is worth mentioning that in hot weather bees store water for the future, as they do with honey). Contrary to the general rule of arranging the drinking bowls in sun-lit places, they are usually installed in the shade and, if possible, on the northern mountain slopes if one lives in a southern country. There the hives are always painted light colours (white or sliverish shades) which reflect the sun rays well.

Good and steady ventilation accelerates water evaporation from the nectar, facilitates the work of bees and relieves them of the necessity to ventilate the nest specially, thus many bees can be engaged in other jobs, and in this way the honey harvesting becomes more intense.

During summer honey harvests, colonies will work much better if their hives are arranged with their flight entrances facing north and not south-east, as they often are. When the flight entrances face the shade, it is cooler inside the hives, and there are fewer bees near the entrances because it is not so vital to ventilate the nest, the bees do not crowd or fuss, their flights are rhythmical and active even in the afternoon. On long summer days, the sun when rising and setting shines right into their entrances, attracting them out of the hive and prolonging their working time until late darkness. The hives are usually installed in this direction when unloaded close to the source of the honey flow.

It was N. M. Vitvitsky who was the first to notice long ago that the productivity and activity of bee colonies differ greatly, depending on the direction of the entrances in the hives. He wrote that... "in summer it is more convenient to locate the hives with their entrances facing only north. The bee swarms in their natural state, working in the forests in tree hollows, serve us in this case, too, as the best possible tutoresses. I noticed that there was much more honey and bees in such tree hollows which let the bees fly northward; the observations were, on the contrary, quite different in those which had their flight openings facing south or west, or in between these compass points.... During swarming, when we usually place empty hives in bee-gardens or in other known areas, some on trees and some on trestles, the swarms

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seem to be more eager and more frequently enter such hives which have their entrance facing north, and rather seldom enter those arranged in a different direction.”

There is a very important reserve for augmenting the productivity of bee colonies. So far, unfortunately, it has been greatly underestimated. We mean combless, queenless bee-packages. It is best of all to use them in areas with an intense or late main honey flow. If colony's flying reserves are strengthened with at least one package of 400 g at the beginning of the main honey flow, the increment in the honey harvest will compensate for the cost of that package by several times. Such packages must be free of drones, and, to achieve this goal, the contents of any package are usually screened twice through a separating sieve (once, when the colonies are formed, and for the second time – when they are strengthened).

In Siberia, the Far East and in the north of Russia the resources of nectar-bearing plants are great, but bees are rather rare. Moreover, in many areas of virgin lands covered with nectar plants there are no bees at all. In such territories the local nectar treasures can be well used by package colonies, but not those which have no queens and are small. Such package colonies must be three times stronger, and their queens should be quite active. These huge resources of nectar may be utilized not only by commercial apiaries, but by amateur beekeepers as well. Packages with strong bees are nowadays mailed to apiarists' societies. It is highly desirable that such packages arrive to these distant regions not later than two months before the onset of the main honey flow. If such packages arrive to Siberia, for example, in early May, the bees will be able to enjoy the honey flow from the willow trees, the early nectar forbs and raspberry, and they will still have enough time to rear many young bees and much brood before the willowherb starts blooming. This brood will support the stability of the colonies throughout the entire honey harvesting.

Package colonies are utilized only within one season. It is neither feasible nor profitable to retain them in winter (to maintain package colonies during the long autumn-winter season costs more than to buy new ones). Besides, they may deteriorate the inheritance of the valuable local aborigine bees. Right after the end of the main honey flow, such package colonies are smoked out.

With the onset of willowherb-honey harvesting in Siberia and in the north, as well as with the early blossoming of autumn forbs in the Far East, the queens in package colonies are isolated from the other bees (they are put into cages and placed in the middle of the lower storeys). Their work during honey harvesting is of no use for the colonies, it may even be harmful. Even if the queen lays her eggs at the beginning

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of the honey flow, the bees born from such eggs will hardly manage to gain strength by the time the honey harvest is already over. And a later brood, which will take so much of the bees' energy for its rearing as well as of its food for its feeding, will not have the proper time to complete its incubation before the day of smoking out comes. After their smoking out, the combs with the addled brood inside cannot be stored, and should be melted.

Package colonies which have a queen and brood in their nests (at first the brood is composed of all larval ages, but then it is made of capped larvae only) can work at honey harvesting quite well; they procure a lot of honey and pollen.

Despite the fact that the isolated queen will always remain in the centre of the nest, the bees frequently lay emergency queen cells. To preclude the appearance of a young queen, which may produce brood by the end of the honey harvest, some eight or nine days after the old queen is isolated the nest is carefully examined and the emergency queen cells are destroyed. The latter may remain intact and one does not have to break them out if the honey flow lasts approximately as long as the emergency queen needs for its development and maturation.

In five to seven days after the honey flow is over (this is determined by the control hive), the honey magazines are removed from the hives. By this time, the bees will have already gathered together all the honey scattered about the hive, they will ripened it and, to a great extent, already capped it.

When the honey is withdrawn, the bees are smoked out. Some part of the colonies is left to dry out the combs, these bees are the last to be smoked out. The combs are taken away for long-term storage. The magazines with their frames free of honey are arranged in stacks over the apiary in such a way that the bees can reach them easily.

The bees are smoked out with sulphur. It is inserted in a kindled smoker and as soon as sulphur dioxide being emitted, it is fed into the hive where the entrance is closed. In three or four minutes the bees will perish.

It is better to smoke the bees out after all the combs of the hive are removed. Then the cells will not contain dead bees.

Package bees are very widely employed by enterprising apiarists in many foreign countries, particularly in the extreme northern states of the USA and Canada where winters last long and are severe. In these countries, the queens are killed immediately after the main honey harvest. Queenless colonies, growing gradually weaker and finally dying, still manage to gather some quantity of honey and pollen and to store it in the combs. The latter are carefully saved to be given to new pack-

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age colonies next spring, so that these colonies will gain strength much faster.

If one observes strictly all elements of the generally accepted technology, he can successfully use the main honey flow, irrespective of its power and duration, in any zone of this country.

Recently another technology, which is more advanced and productive, has been introduced into beekeeping, the basis of which is two-queen apiculture.

The Colony Is Worked for by Two Queens

B

ecause of the nature of modern agricultural production, the conditions which the honeybees used to enjoy not so long ago have changed drastically. The ploughed field planted with main field crops have increased greatly, while on the contrary, the natural honey-bearing territories, which once served as the main source of food for bees, have decreased. Vast lands are now sown with field crops, among which there are many nectar-bearing ones.

In the areas planted with fodder herbs, such as sainfoin, clover, lucerne, coriander, buckwheat, sunflower, and many other nectar-bearing crops, the stores of nectar have not reduced but increased, and in some places to a great extent. And the most important thing is that they have become concentrated.

These new conditions have naturally brought about changes in the technology of beekeeping. These changes have primarily involved such stages in apiculture which condition the accumulation of bees and the maximum use of honey flows.

The new feature of this new technology is that now not one queen works for the colony, as was the case in the past, but at a certain time the colony is served by two queens simultaneously. Owing to this, now one can shorten considerably the long period necessary for raising a strong colony under traditional conditions whereby only one queen is used. It has also become possible to breed large reserves of bees and of brood, and with their help the colonies are now able to gather much more honey not only from the first main honey flow, but equally well from the subsequent ones.

As C. L. Farrar, an outstanding American apiculturist, wrote, by dividing strong colonies some six to eight weeks before the main honey flow so as to establish two-queen colonies, one intensifies the brood-rearing at the beginning of the season and thus heightens the honey production during the main honey flow.

Powerful two-queen colonies increase their pollination activity

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which is more effective for improving the crop capacity of the plants they pollinate.

The practice of two-queen beekeeping has to a certain extent ammended some theoretical aspects of apiculture. Many a time have biologists attempted to prove that highest honey yields can be obtained from bee colonies weighing 6 kg and even less. However, it is well known that all the highest honey yields in this country and abroad have been obtained from colonies weighing 9 or 10 kg each and even more, and that their heavy weight was gained not without the help of their second queens.

This two-queen system of beekeeping did not come into being spontaneously and accidentally. It is believed that the first page of this species history – insects which are known to live in communities – reveals their having many queens at one time. It is most likely that the cases of prolonged peaceful coexistence between two, and occasionally three queens in the same colonies, which may be encountered rather frequently in honeybees, may be regarded as an echo of a biological trait typical of their distant ancestors.

In the requeening, the coexistence of two queens is found in all bee breeds without exception. It is known from practice that there were two queens in the same cluster which were completely unseparated but still lived together happily through winter.

Usually nature carefully guards the individuality of every living organism and protects it zealously. But it does not seem to be very strict about the individuality of honeybee colonies. While swarming, for example, the swarms leaving their different colonies, simultaneously or one after another, very often join together (two or three of them and even more sometimes) to make one integral swarm. It is very characteristic that, being of different origins, they nevertheless come to live together quite peacefully. Moreover, when settled in one dwelling, they all work with outstanding energy.

Such combined swarms are justly called honey-rich for their high honey-gathering capacity. Honey-rich swarms were successfully used in practice by A. S. Butkevich, a famous beekeeper and experimenter, as well as by other outstanding Russian beekeepers.

Nature has not excluded another kind of natural violation of the bee colonies' individuality. A swarm which has failed to find itself a home beforehand may sometimes have to beg some other bees, which have already settled down in their nest, to let them join their colony, and the latter usually welcome such homeless ones.

During their spring orientation flight, the bees may frequently wander and by mistake enter hives with alien colonies which thus become stronger. Sometimes, whole colonies do not return to their

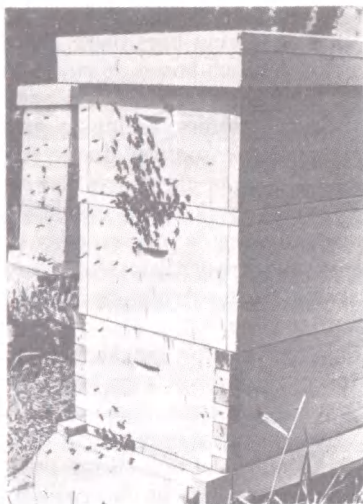


Colonies with reserved nuclei before they join together.

own nests but remain in those which belong to other colonies.

And, feeling the danger of a rain storm, a large amount of bees start flying back home in a hurry. If they find foreign apiaries on their way, thousands of them may not return to their own nests at all. Many bees will settle in the hives situated at the frontal edge of their own apiary, this is particularly so when the bees are heavily laden with nectar.

Colonies which accept foreign bees become much stronger, occasionally by several times, and their productivity augments greatly.



Two queens working in the hive.

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The method of two-queen beekeeping is based on the most important biological feature of honeybees, namely on their capacity to unite under certain conditions and to make one big colony, coming to it from their own ones, so as to live peacefully together and work actively in one integrated strong colony.

The world of beekeeping today has been using in practice some elements of the two-queen technology for a long time, and this system was chosen involuntarily. It has become a traditional way to take overwintered and weakened colonies, which are unable to grow independently or for some reasons are found to be motherless and doomed to perish, and to join them in spring to some other colonies. The colonies, strengthened in this way, can work much better on early spring nectar plants and gather more honey.

Not all colonies can prepare for the main honey flow equally well. Those which are short in bee reserves and therefore fail to yield commercial honey are usually joined to others, traditionally the neighbouring ones. Such measures, as a rule, are justified as it considerably increases their productivity.

It has become a rather frequent practice to strengthen good colonies by some others of the same quality. For example, in the area of the Altai Mountains, the spring is too short and the bee colonies cannot rear large flying reserves for the main honey flow from the yellow acacia.

Therefore the local beekeepers arrange the hives in pairs, and when the honey harvest begins, one hive of each pair is set aside to concentrate the flying bees there. Such a reinforced colony gathers about twice as much honey as could be collected by both of the colonies if each of them worked independently.

Some colonies, failing to prepare well for winter, cannot tolerate the winter season well due to their weakness. Therefore they are united by twos or threes, or else are used to strengthen other colonies. Everyday beekeeping practice long ago proved that such colony-strengthening is very expedient. Strengthened colonies are known to live well through winter and to make good use of all honey flows in spring. Such colonies are also helpful for organizing new nuclei at an earlier time.

When joining weaker colonies together, the beekeeper simultaneously improves the breeding properties of his bees. And this is of great importance, too.

A significant component of current beekeeping technology is the arrangement of anti-swarm nuclei. Besides their direct purpose, such nuclei have become the basis for raising additional reserves of bees and brood which can be well employed to strengthen the colonies for

Two Queens Work for the Colony

the time of honey flows. Such nuclei have turned into an integral whole of two-queen apiculture.

Colony-strengthening was practiced by N. M. Vitvitsky long ago. He used even ordinary bee tree (frame hives did not exist yet in those days). He divided a tree hollow into two parts and settled bee swarms in each of them, making a 40 mm hole in the partition separating them, and closed it with a plug. When the main honey flow began and it was necessary to have one powerful family, Vitvitsky removed the plug and compelled the swarms to unite. "The working bees," he wrote "will kill the queen which is less perfect, and after that the two colonies will both live friendly as if they are offspring of the same mother."

Two-queen beekeeping is most productive when there are several main flows, be they short or long in duration. There are a few ways to raise additional bee reserves and to start them working. These methods are determined by the onset time and pattern of the main flows.

Strengthening with flying bees. This technique is employed for utilizing short strong main honey flows when particularly large numbers of foraging bees are vitally required, and each and every hour is extremely precious because there is honey flowing from the white and yellow acacia, from linden and from willowherb.

The period after wintering until the blossoming of the acacia is comparatively short, and therefore colonies, even if they are good, have too little time to rear large reserves of flying bees.

By this time the overwintered bees are already replaced by young ones, the nests will be filled with the brood. The weight of the colonies is quite considerable and goes on increasing. The colonies grow but they are obviously short of large reserves of flying bees which they can make use of if necessary. At least half of the honey harvest remains ungathered by such imperfect colonies. Therefore colonies with maximum reserves are made artificially.

To reach this goal, nuclei for a given year are usually formed in the summer of the preceding year. The best time to do it is when the last main nectar plant begins to bloom.

In multiple-storey hives such nuclei are arranged during wintering in the pattern of one nuclei above every nest of strong colonies. The dividing bottom or ceiling, separating the nucleus from the colony, has a hole through which the bees are removed. This hole is covered from both sides with a metal thick grid.

Having wintered well, the nucleus will develop normally in spring and will be able to strengthen the colony for the period of early honey

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harvesting if it can have four or five complete streets of bees. In winter, the nest with its food stores is located in the middle of the storey, opposite the flight entrance.

Some foreign apiarists prefer to keep their nuclei on moving nets. To prevent the bees of one colony from flying to the hive of another, the storey with the nucleus is usually positioned in such a way that its entrance faces its rear side.

The nuclei receive sufficient heat from the strong colonies, since their clusters are arranged above those of the latter. Therefore, the nuclei do not consume much food, and they usually winter well.

The air exchange in the hive is effected through both flight entrances of the lower colony, through its ceiling hole, and through the entrance and ceiling hole of the nucleus. The colony and the nucleus are separated and placed apart.

In spring, colonies and nuclei grow independently. When capped brood accumulates in the colonies' nests, some part of it (two or three frames without bees) is transferred to the nuclei.

When bees are kept in 12-frame hives, the nuclei made of four or five frames are placed in separate hives close to the maternal colonies; in long hives they are arranged by the side of the maternal colonies with their flight entrances facing the side or back. Both in the former and in the latter, the nuclei are from time to time strengthened with mature (ready to leave) brood.

By the onset of the acacia honey flow, the overwintered nuclei usually occupy a storey each, while their maternal colonies have two storeys each and continue to grow.

As soon as the control hive shows that the honey harvest has started, the flying reserves of the nuclei are transferred to the maternal colonies. When the bees are kept in multiple-storey hives, the reserves are withdrawn with the help of the dividing bottom.

Unlike the ordinary bottom, the dividing one is fastened from all four sides. Its top and bottom protrude above and below the floor respectively by only 8 mm. The front and the back sides of the fastener have two slit-like entrances 60 mm wide (Rumanian beekeepers make their entrances in the front and back walls of the fastener and also at its sides, shaping them as cones). When the nucleus and the maternal colony develop and work independently, all flight entrances cut in the dividing bottom, except the upper one in the back wall, are closed tightly. If the nucleus receives an infertile queen, this will prevent her from setting into the entrance of the maternal colony on her way back from mating.

To facilitate the work of the bees in the nucleus, the nucleus storey is shifted towards the front wall of the hive to one half of the width of

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the fastener of the dividing bottom. The part of the bottom so revealed will serve as a special flight board.

When withdrawing the flying bees, the working flight entrance of the nucleus is closed tightly and the one beneath it is opened. To provide a flight board for the bees, the nucleus storey together with the bottom are shifted aside to one half of the width of the storey wall. Simultaneously, the upper back entrance in the dividing bottom is opened. Through this bee entrance the bees of the nucleus will fly for the honey flow. On coming back, they will follow their reflex and will try to penetrate their nest through the flight entrance they are used to. But since this one is now closed, while just a mere centimeter below there is another which is opened, though leading to the maternal colony's nest, the bees will enter the latter.

Such withdrawal of the bees from the nucleus and their transference to the maternal colony goes unnoticed by both colonies and does not require any special time or labour expenditures for the beekeeper.

To provide sufficient room for the nectar, the nests of the basic colonies are enlarged by means of magazines. The nuclei, and together with them their entrances, will naturally be elevated. Seeing this changed position of their flight entrances, the flying bees will for some short time feel confused. But then they will soon get used to the new location of their flight entrances.

The dividing bottom may also be employed for returning the withdrawn bees back to the nucleus, if necessary. For example, a strong honey flow was expected, but the weather conditions suddenly changed (a drought occurred) and it proved to be greatly reduced. Under such conditions, strong colonies may burst into swarming, and consequently they will not be able to utilize the next honey flow properly. To preclude such a possibility, the lower entrance in the dividing bottom, which has already become habitual for the bees, is closed and the one above it (leading to the nucleus) is opened. This combination with the flight entrances not only helps the bees which previously left the nucleus to return, but also to attract some bees from the maternal colony's reserves, which by this time have already started their work, and to direct them to a new entrance.

To withdraw flying bees from nuclei in 12-frame hives, the hives are carried to a new place. To make use of the nuclei's reserves in long hives, the hives receive a common magazine. The nests are opened only partially, just along their sides, by slightly pressing the linens down, or by taking out one ceiling beam after another. The diaphragms isolating the colonies from the nuclei are not removed. Each colony, both the basic one and its helper colony, retaining their own independence, will work together in their common magazine. The

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bees will enter and leave it through the opened parts of the nests. As seen from practice, the queens do not enter the common magazine. After the acacia honey harvest is over, the nuclei go on growing and accumulating their reserves.

With the onset of the sunflower honey flow, from the nuclei are withdrawn not only their flying bees, but at least half of each nest with the brood, for the most part mature, as well as its young bees (without the queen).

Each of the remaining parts of the brooding nest is used as the basis for a quite vital nucleus which will last through winter. This nucleus may only need to be supplied on time with food to replenish its own stores.

When the main honey flow occurs in summer, it is usually violent and strong (for instance, the linden honey flow or that from willowherb). If under these conditions the nectar plants, blooming before those of the main honey flow, also yielded a lot of honey, they favoured the growth of the colonies which contained enough bees to use the strong honey flows to their utmost. Nevertheless, when such strong colonies receive additional reserves, their productivity still increases, and the stronger is the honey flow, the greater is the increase in the colonies' power. All expenditures for maintaining auxiliary colonies usually pay for themselves several times over.

The best results can be obtained by using auxiliary colonies based on overwintered nuclei. Since during the summer main honey flow the growth period of bees to be used for strengthening other colonies lasts rather long, it is not necessary to wait till the auxiliary nuclei get strong before they enter the winter season. Besides, strong nuclei would require large food stores. Therefore nuclei are made small, of three or four frames, their bees weighing 500 to 600 g. Such nuclei are formed at the end of the last productive honey flow. They can endure the winter better if kept in pairs above the colonies' nests.

A plywood floor is nailed to the storey to house the nuclei. The floor has air holes at the sides of the dummy diaphragm dividing the storey into equal parts. The holes are covered with a thick grid on both sides. A flight entrance is drilled in the opposite sides in each part. The nests are situated close to the diaphragm. Since in the pair-maintenance of bees the clusters are usually set right near the diaphragm, the frames with honey, which are installed near it, should weigh at least 2.5 kg. The remaining 3.5 to 4 kg honey should be in other combs.

To provide for better gas exchange inside the hive, the ceiling in the nucleus should not be overheated.

In spring, before the bees start their cleansing flights, the nuclei are

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disengaged. One of the nuclei remains in place, the other is arranged above the nest of the neighbouring colony. Both colonies are constantly strengthened by ripen brood, they are steadily supplied with honey and beebread. As the colonies grow, particularly when they start bursting into swarming, the nuclei receive two or three more frames with capped brood, while one or two frames with uncapped brood are withdrawn from them. Such strengthening is usually quite sufficient to turn the nuclei into strong colonies by the onset of the main honey flow. By that time, each of them will occupy two storeys, and the basic colonies will also be strong enough and in good working condition.

With their reserves of flying bees joined, the colonies become genuinely "honey-rich" in the full meaning of this term. To accommodate the nectar they will now be collecting, the beekeeper will have to enlarge the volume of his hives by at least two times.

The storeys with the nuclei are now removed and placed on new bottoms located behind the hives. Soon the nuclei will have their bees' flying activity restored: younger bees will now function as foragers which were transferred to the basic colonies.

The nuclei begin raising their new reserves which will be able to use the next honey flow.

Colonies may be successfully strengthened by package bees, too. Such bees are usually raised by bee-breeding nurseries. A bee package costs about the same price as 8 or 10 kg honey, and a colony, strengthened with the bees from such packages may gather so much honey that it will exceed this amount by several times. The most ideal package for strengthening the bee colonies is combless, containing 1.2 kg bees.

Transfer of bees and brood. In some areas the honey flow may be not only strong but also long, lasting up to one month. Such conditions may be found in zones rich in willowherb, or in some territories of the Far East where three varieties of the linden grow. If, in addition to the strong and long honey harvest, the locality has a dissected and hilly relief, the intensity of bees' flights may become much weaker towards the second half of the honey-gathering period, because the bees will wear themselves out too much, and the number of dying bees will not be compensated for by newly born ones.

To help the colonies maintain their power till the end of the honey harvest, they receive not only the flying bees, but also some part (three or four frames) of the capped and more mature brood. These frames are put in the brooding storeys instead of the honey combs. In the middle of the honey harvest the colonies are strengthened again with

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the flying bees of the auxiliary colonies. During the time of the main honey flow the nuclei gain weight.

Beekeepers in the Far East increase the flying reserves of their colonies by using early spring nuclei. They are formed at the beginning of the second decade of May by getting queens specially prepared by this time. The nuclei gradually receive mature (ready to leave) brood. Such strengthening helps the queens to speed up their egg-laying, while some withdrawal of the maternal colonies' brood will prevent them from early swarming, though their growth will not be retarded.

Some 45-50 days before the linden blossoming, the nuclei will become almost as strong as their maternal colonies. This way of increasing one's reserves of flying bees is quite practical and rather effective.

If the traditional short and strong honey flow from the linden is followed by the main honey flow from coriander, buckwheat or other nectar plants, the colonies are strengthened with the mature brood which is quite abundant in the nuclei at this time. When the nectar plants start blossoming, the colonies should receive four or five frames with brood. The newly transferred reserves will not initiate their activities within the first few days. By the time of the universal blossoming of all nectar plants, the bulk of the brooding bees will hatch and begin taking part in all jobs in the hive; after that they will by-and-by start gathering the nectar. If the honey harvest lasts more than a month (the buckwheat is sown at different times), such strengthening will prove to be even more useful. Quite significant increases in honey harvests can be obtained by strengthening the colonies with bee packages, giving 500 to 600 g of bees to each colony.

Joining of auxiliary colonies. To insure the maximum use of the last honey flow of the season (from the sunflower, heather, cotton, etc.), auxiliary nuclei are joined to the main colonies. By this time, having worked during several main honey flows, the colonies are much weaker, even though they were strengthened a few times artificially. The quantity of brood in the nests greatly diminishes (when the flow of honey is good, the bees restrict their queens' work).

To help the colonies regain their power and enable them to utilize maximally this last honey flow too, they are supplemented with complete nuclei. It is best of all to do it at the very beginning of the honey harvest and never later than one month before its end. In multiple-storey hives, the beekeeper removes their dividing bottoms. In long hives, he opens the brooding nests as wide as possible and removes the diaphragms. Nuclei from 12-frame hives are installed on top of the main colonies' nests. To unite bees from different colonies, a sheet of

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paper is arranged between their nests. The magazine of the lower colony is moved upward. If the nucleus had its nest storey with a magazine, the latter is placed between the brooding storeys of the strengthened colony, and from its top and bottom it is separated by sheets of paper. It accelerates the process of unification which then becomes absolutely safe. All magazines are now concentrated on the top. Upon such joining, the united colony usually has one queen, which is, as a rule, young and strong. Thus strengthened the colony will be quite able to gather much honey from the last honey flow, too, and to prepare well for the winter season.

If one needs to make his colonies even stronger, so that they will not only be able to winter well but will also rear large reserves which the beekeeper will use next spring for an excellent honey harvest from the willow trees or from other early nectar plants, he puts the old queen in a nucleus of four to five frames. In this way he may additionally rear many bees and much brood and use them for strengthening his colony after the honey harvest. Then the old queen will be killed, or it may be left in the nucleus to be employed as an assistant queen during next year.

So, *the two-queen system of beekeeping is universal. It expands our abilities in governing the growth and development of bee colonies. It insures large bee reserves by the time of main honey harvests. Owing to this technique, we can maintain the high working capacity in our bees throughout the entire season and obtain record-level honey harvests. We can also replace old queens by new ones annually and make our colonies weigh up to three kg by the onset of the winter season.*

The honey withdrawn from the hives must be absolutely ripe. Depending on the plant species which the nectar was collected from, honey composition may involve dozens of vitally important elements. It is comprised of about 76 per cent sugar, 74 per cent of which consists of fructose and glucose. The latter enter the human blood without any preliminary processing. In addition, honey contains a great number of highly valuable elements, such as potassium, calcium, sodium, nickel, tin, manganese, chromium, phosphorus, silicon, aluminium, magnesium, iron, titanium, copper, cobalt, molybdenum, vanadium, silver, lithium. All these elements play an important role in metabolic and hematogenic processes. Honey also contains such enzymes as diastase, catalase, invertase, turonase, and some others which speed up the decomposition of complex nutrients in the organism, making them simple and easy to absorb. Honey contains vitamins C, K, E, and some from the B group, etc. It also contains protein, amino acids, lysine, histidine, arginine, aspartic acid, glutamic and other acids

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which are very important, for they normalize the activity of human organs and strengthen man's health.

However, this wonderful set of most precious elements is typical only of ripe honey which is seasoned in the bee nest where the humidity does not exceed 18%. Such honey is usually found in combs sealed with wax caps.

It was found that the nectar brought to the hive turns into natural honey only after the bees have actively worked on it for at least seven days. During this period the excess water in this honey is evaporated and the inversion process is completed. The honey becomes thick, heavy and sticky. But beekeepers have noticed that the bees do not like to seal honey of this age, they seem to season it for a while. It is believed that, owing to its capacity to absorb various smells, the honey of this age gets enriched with aromatic substances, in other words, it absorbs the aroma of the hive and attains its final natural properties. But the process of honey-seasoning goes on even after the honey gets sealed with air-proof wax caps.

It should be added that honey inversion (the decomposition of complex sugar into simple sugars), due to the effect of invertase, goes on slowly in the ripe honey which has been centrifuged during its storage.

So, until the honey has ripened, it cannot be regarded as being of top quality. To provide man with this most valuable gift of nature in its best natural form, so that it may be of greatest possible use, the beekeeper should withdraw it from the hives only after the end of the honey harvest; when removed after the last honey flow (at the end of the season), the honey must be seasoned in the nests for at least two weeks. It is true that even after this period one can sometimes find unsealed honey in the hives, particularly in the lower part of the honey combs. But at this time such honey will always be ripe. As a rule, the combs with this honey are filled not to the top but only halfway, or somewhat more; this seems to be the reason why the bees do not cap them. They do not process the unsealed honey any more.

Many beekeepers believe that honey can be removed for centrifuging if the upper part of the combs is already partially capped. But this opinion is wrong. Moreover, we think it is even harmful to withdraw the honey during the honey harvest as often as possible, without waiting for its being capped. The water content in such honey is frequently almost double the acceptable standard. The inversion process in such honey is not completed yet, the bees have not yet enriched it with the necessary enzymes. Such honey may be compared with unripened fruit.

Unripened honey is of low quality, it cannot be stored long because

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it will soon sour. It is true that excess water can be removed from un-ripened honey artificially by seasoning it in open vessels at a low air humidity and high air temperature. But to imbue it with the high medicinal and nutritious qualities which it is given by the hive bees, is beyond man's power. The unripened honey is not well crystallized, its density is low, and it can easily and frequently get scaled.

It would be ideal to serve honey at one's table in its nature-created shape, i. e. in combs. Such honey would not touch the metal parts of the extractor, and its precious aromatic substances would remain un-volatized during its centrifuging. Comb honey, especially if it has just been withdrawn from the hive and is still warm, is simply heavenly, and there is no more delicious sweet that can equal such honey in its flavour. Unfortunately, we must centrifuge the honey from the hive, in other words, to extract it artificially from its natural combs.

If honey were used straight from the combs alone, great numbers of combs would be destroyed, and without combs it is simply impossible to maintain modern rational beekeeping. Nevertheless, honey right from the combs is hard to refuse.

Such honey can be taken only from honey magazines and frames of young, freshly-built combs without any beebread inside. To use the comb honey in a more convenient way and to make it still more attractive in its appearance, or, as some people say, to shape it as some commercial commodity, beekeepers use original small frames which are called frame-sections.

A section is $110 \times 110 \times 40$ (or 45) mm in size. One of its sides has a slit for fixing a piece of foundation. Such small frames complete special magazines employed in multiple-storey hives. Depending upon the width of the frame, each magazine has 32 to 36 sections.

Before the hive receives such a magazine, the hive volume is partially diminished, all storeys above the brood are removed and the magazine with the sections is installed right onto the nest. Such a decrease in the hive volume may compel the bees to swarm. Therefore one installs the sectioned magazines only when a good honey flow obviously begins because then the bees will immediately plunge into their work which will repress their swarming instinct. Because of their increased crowding, the bees will sooner occupy the sections and fill them with liquid honey. Two or three days later, when the sections are filled with honey to some extent, another magazine of the same kind and size may be placed beneath the first one.

With this arrangement of the magazines, the bees in the hive, particularly those of the Middle-Russian and of the Italian breeds, will first of all fill the sections in the upper magazine with honey, and then those in the lower one.

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The honeybees of these two breeds have another biological peculiarity. In their vertical nests, they begin to concentrate their ripe honey in the middle combs, and then by-and-by those on the sides of the hive. The same regularity is observed in their capping of the combs. To have sections completely filled with honey and well capped, the middle combs, when they are amply filled, are brought to the edges of the hive, while those from the edges are put in their stead to be finished. Such rearrangement of the sections is particularly vital if the honey harvest is not intense or is coming to its end.

It may happen that the bees fail to prepare sufficient stores of food to last through the winter because the previous honey flows were not good enough. In such a case, it is better to return one of the previously removed storeys, the one richest in honey, back to the nest, instead of the second sectioned magazine.

When bees are kept in long hives in which they build their nests not taller than broad but wider than tall, contrary to their nature, the main stores of honey are located not above the brooding part of the nest but along its edges.

Special magazines for section honey are not installed in these hives. But one can still get such honey by putting these sections in ordinary magazines or nest frames.

Industry manufactures special sections 103×110 mm in size for such hives. Each magazine frame contains four such sections. Bees usually fill the minor gaps between the sections and the frame planks with propolis or wax. The sections become fixed so firmly that it is necessary to use an apiary knife for removing them.

The frames with sections are installed in the middle of the magazines by five or six at a time; at their edges one puts superframes with combs. When the honey flow is strong, the magazine is filled with the section frames not partially but completely, and then it is installed, like in multiple-storey hives, right onto the nest beneath the first magazine which by this time is already filled with honey.

The decisive factors for production of section honey include a great power of bee colonies, their high working capacity, a good honey flow, and a crowded nest.

Sections will look more attractive if their honey is sealed with white wax caps (this is how the Middle-Russian and Italian bees cap their honey) and gathered from plants yielding light-coloured honey which is highly appreciated for its aromatic, palatable and medicinal properties. Umbelate plants, such as the angelica, cowparsnip, and also the buckwheat, sweet chestnut, and heather produce dark honey. The commercial condition of sections with such honey is rather low.

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Therefore it is not recommended to supply magazines with section frames during honey flows from these plants.

This honey is to be used as bee food. It is best of all to remove the honey from one's hives on the day when one travels with the bees to new sources of honey flow, or when the honey harvesting season comes to an end, if he failed to reach the place with abundant nectar plants.

In preparing his bee colonies for transportation, one takes honey magazines from his 12-frame hives and replaces them with magazines of empty combs. In long hives, if they had no magazines, nest frames with sealed honey are removed to be replaced by frames of empty combs or, partially, of foundation.

In multiple-storey hives one takes off the upper honey storeys or magazines with sections, if their honey is already sealed. Storeys with unripened honey remain intact in the hives to be transported to the new sources of honey flow; the removed magazines are sent back home.

If the bees collect honey in warm weather, which is very beneficial for nectar secretion, particularly when there are intermittent rains, such honey proves to be of top quality. It is quite good to feed the bees in winter.

This honey is used to make the basic food stores: colonies in multiple-storey hives receive one full storey each, those in 12-frame ones get a magazine each, and the bees in long hives are provided with six or seven nest frames per colony. These stores are minimal and should be preserved as emergency supplies. They are usually returned to the bees after the colonies complete their autumn growth while preparing for winter.

Nest frames with honey to be fed in winter are chosen from those which are light-brown in colour, well and properly built and, most desirably, without drone cells. These combs will be the basis of the future spring nest of the bees.

If the bees collect their honey in hot and dry weather, it will, as a rule, contain honeydew. The latter is a product which causes a special kind of toxication in bees, augments their intestinal diseases, leading to considerable weakening of bee colonies and even to their death, if the bees were infected with nosema disease. Honey is no good for the winter if it is mixed with honeydew.

As a rule, the beekeepers do not preserve for winter the honey gathered from the Cruciferae family (such plants as the winter cress, mustard, Camelina). This honey will inevitably get crystallized in the combs and will become practically inaccessible to the bees. Sunflower

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honey also crystallizes quickly, especially when stored for winter unsealed. Ripe sunflower honey does not crystallize so fast if it is stored in freshly built and light-brown combs which were previously free of old honey. The bees using capped sunflower honey can pass the winter season quite well. But they do not winter well when fed on heather honey.

Honey combs stored to be given to bees in winter are kept in storeys, reserve hives or comb depots (special lockers, trunks). They are firmly closed to preclude any intrusion of wax moth, robber bees or rodents.

All the rest of the frames are centrifuged to extract the honey.

Honey is separated when it is warm and it is stored in a cool place. Honey is extracted from combs during honey separation. This process involves three consecutive operations: the honey combs are seasoned under warm conditions, their wax seal is removed, they are centrifuged to extract the honey.

When the honey is still warm, in other words, it still retains the temperature of the nest, it can be extracted from the combs quickly and without any difficulties. But at this temperature the combs are soft and, when centrifuged, they fail to resist the centrifugal force, cut into the cassette grid and get smashed; they may even break up.

The same picture can be seen when centrifuging honey which has cooled down to the environmental temperature, particularly if it is below 20 °C. Under such conditions, the honey becomes more viscous, and it is hard to extract it from the combs during centrifuging. In such cases, a lot of honey remains on the walls of the cells. Striving to extract the honey completely, one will inevitably destroy the combs, especially those which are freshly built, and these are of particular value.

As seen from experience, honey does not become too sticky and can be easily extracted when the temperature is 25 to 27 °C. At this temperature the combs are sufficiently strong. If the beekeeper fails to extract the honey on time and it cools, it should then be kept for twenty four hours where the air temperature must be 25 to 27 °C.

When sufficiently warmed up, the combs are unsealed and immediately separated (all windows and doors in the room must be closed or screened to prevent any penetration of the bees).

The best and the fastest way of removing the comb seal is by using a hot knife. A steam cutter or an electric knife are very convenient for this purpose. One takes the conventional apiary knife and heats it in boiling water. As a rule, the beekeeper works with two knives, alternating them.

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There is no universal rule for unsealing the combs with a knife, but it is more convenient to work with the comb when it is installed on the lower corner of the frame or on the lateral plank. If the honey comb is smooth on the surface, it can be opened with the knife over its entire plane.

The apiary knife can best open the comb by moving it slightly horizontally (to and fro). The comb with its unsealed honey is inserted in the centrifuge. Then another comb of approximately equal weight is unsealed and put inside another cassette. If the extractor is of four cassettes, it is loaded with two more combs of the same weight. Then the rotor (basket) will move smoothly and there will be no vibration in the centrifuge.

Frames for centrifuging are chosen according to the age of their combs. It is not desirable to have freshly built and old ones in the extractor together. The former are much more tender and weaker than those older ones of a brown colour; it is better to extract honey from them separately, using a lower rotor speed.

When using a chordal extractor, one installs the comb with its lower plank touching the axis of the cassette, so that the entire comb plane is firmly attached to the cassette grid. The rotor is started in the direction of the lower planks of the frames, first clockwise, and in the reverse direction after the cassettes are turned over.

Bees build the cells of the combs at a slight upward angle, therefore when the comb is in the vertical position the honey in it does not drip out. When the comb moves with its lower plank forward, the direction of the cell walls almost coincides with that of the centrifugal force, and, affected by this force, the honey will more easily spill out onto the walls of the extractor. When the rotor moves in the direction of the upper planks of the frames, the centrifugal force, on the contrary, will render heavy pressure on the cell walls and will, to some extent, prevent the honey from spilling out. If the rotation speed is accelerated in such a case, the cells may get deformed and the combs may break up.

Irrespective of the comb types it is loaded with, the rotor is first started at a low speed, but at such a revolution which permits the honey to spray out onto the walls of the extractor. One can easily see or detect this by the peculiar noise the honey makes inside the extractor. At these revolutions, the extractor works for one to two minutes. It is not permissible to start the extractor at a high speed at once, since due to the effect of the centrifugal force, the opposite side of the comb, its honey being still unextracted, will press heavily on the mid-rib of the combs and it will break up.

To prevent any destruction of combs, the beekeeper first extracts on-

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ly some part of the honey (usually half of the entire amount) from one side of the comb; then the cassettes are turned with their other side up, and the rotor is moved in the opposite direction until the honey stops spraying out onto the extractor walls. Then the cassettes are installed in their original position and the honey is separated completely at high speed. As soon as the honey reaches the top of the bottom cone, it is sent down through a tap and filter (a screen) into an enameled saucepan, a bucket or any specially prepared container. Wax particles of destroyed cells get inside the honey during its extraction. They are all stopped by the filter.

As seen from practice, such honey extractors (centrifuges) in which the combs are arranged radially, with their lower plank facing the rotor axis, are more productive. Despite the high speed of rotation (the radial extractor is driven by electricity), the combs there almost never get destroyed, even when freshly built.

The best container to keep honey in is that made of wood. It is usually made of linden (a linden jar), cut from a single piece of lime, or of riveted cedar, beech and plane (lagoons) tree. Linden jars are usually small (for 10 to 20 kg honey) and lagoons can hold as much as 40 to 50 kg, and even more. Honeyware made of coniferous trees is no good for honey storing because it gives the honey an odour of pine. When kept in oak jars, the honey turns black; aspen jars make it bitter. It is possible to store honey in milk cans, in flasks manufactured by industry, or in small glass jars.

After a day or two, when the container is completely filled with honey, one takes away all wax particles which passed through the filter and are floating on the top of the honey.

Honey is stored in a dry place with an air temperature never exceeding 10°C . At this temperature the air humidity is usually low, the honey does not liquify; the microorganisms (yeast fungi) causing the fermentation and souring of honey do not multiply under such conditions; honey crystallization proceeds most intensely, while all of the best qualities of honey, such as flavour, medicinal and nutritious properties, remain intact. The air temperature of 13 to 15°C is thought to be the most conducive for the multiplication of honey yeast fungi and for honey fermentation. At 25 to 27°C , honey begins to alter its colour and lose its flavour.

The premises where honey is stored should have no alien smells, since honey absorbs all kinds of odours and becomes unpalatable. Honey possesses great hygroscopicity. To prevent it from liquifying (thinning) at higher air humidity and from any dust penetration, the containers with honey are closed as tightly as possible. It is not advisable to store honey in the sun light either.

Two Queens Work for the Colony

If the honey was extracted during the honey harvest, the combs after their centrifuging are returned to the hives when the next magazines are installed there. Those combs from which the honey was extracted after the last honey flow ended are usually given back to the bees for drying. If wet combs are stored for a long time, especially in a poorly ventilated place, they may frequently get damaged: the honey will be thinned if the weather is damp; the combs will be moistened. The walls of cells which were not properly dried will be covered with sugar crystals as the time goes on, and the honey will get crystallized in the nests that will later receive such combs.

To dry the wet combs, they are given to bees, particularly when there is no honey flow; all precautions should be taken to preclude any chance of bee robbery. In autumn, such attacks of alien bees are much more dangerous because their numbers increase by several times, as compared to spring. Therefore it is more feasible to give the combs to the bees for drying when the weather is gloomy and cool, or during the night time. One fills his storeys and magazines with combs to be dried beforehand and puts them (by twos or threes) into hives with strong colonies. Any slots or slits between the magazines should be carefully glued.

The bees will dry the combs much faster when their nest is almost isolated from them. The nest is opened only partially: the canvas is pressed down only in one of the back corners, the terminal ceiling beam is removed from the dismountable ceiling, and a hole for the bee escape is opened in the dead ceiling. The upper flight entrances are closed, the lower ones are reduced in size. After a day or two, the storeys containing the dried frames are withdrawn. This operation should be done when the bees terminate their flights.

Frames with empty combs are immediately taken away for long-term storage. Like honey combs, empty ones may be kept in vacant storeys, in magazines, one on top of another, in trunks, chests, and closets, in short, in any place inaccessible to mice and wax moth.

To repel the moth, one puts in his comb container and above the frames some pieces of orange peel, stalks of mint, wild marjoram, wormwood, and hop.

In recent years, many apiarists have made it a practice to leave their combs for winter without drying. They store these combs in well-dried and well-ventilated premises. When returned to the bees the next season, the bees get used to them sooner. The combs are installed in magazines to obtain commercial honey.

A large stock of combs is a very important component of beekeeping technology, especially in two-queen beekeeping. The two-queen method is a way to achieve the maximum productivity of bee colonies.

Bees Also Provide Pollen and Royal Jelly



In the last few decades, world apiculture has started to produce large quantities of pollen and royal jelly. In this country, the beekeepers of Latvia alone annually procure up to 80 tons pollen, and those in the Kuban area—about 2 tons royal jelly.

The great interest revealed lately for these by-products of honeybees can be attributed to their high content of biologically active substances and other valuable compounds which are of great benefit for human health. In addition, pollen is very useful for apiarists themselves, particularly in zones where there aren't enough nectar plants. Pollen is especially precious for beekeepers working in greenhouses.

Pollen pellet in the pollen trap. Bees begin gathering pollen right after their spring orientation flight. They carry their pollen pellets from the alder, nut trees, coltsfoot, and other primroses. The inflow of pollen increases when the willow trees burst into bloom, followed by the dandelion; by summer it reaches its peak, and then, by-and-by, it decreases. Bees are looking for pollen until late autumn, as long as the weather permits them to leave their nests.

Pollen is a protein fodder. Brood rearing is impossible without it. Therefore there is a natural direct dependence between the arrival of pollen to the nest and the amount of its brood. The greater the brood, the more pollen it requires, the more intensely will the bees fly to collect the pollen. Uncapped brood stimulates the bees' search of pollen-bearing plants.

The pollen-searching flight is particularly intensive in colonies with young fertile queens where the nests are usually abundant in uncapped brood. The longer the colony's growth period, the more pollen it will gather. To maintain this state and condition of bees during the universal blossoming of pollen plants is one of the primary necessities of pollen production. The ability for pollen production and the very pollen productivity in queens diminishes when their egg-lay-

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ing reduces due to scarce food stores (less than 10 kg) or lack of rich honey flows. In such cases, colonies receive additional stimulative feeding. When preparing for swarming, colonies almost cease gathering pollen.

It is only a strong colony that can allocate sufficient flying reserves for pollen gathering. So, the second condition necessary for high pollen production is to make one's colonies powerful and energetic. Weak colonies will yield neither honey nor pollen.

As apiarists now believe, a normally developed colony, provided the weather is favourable, can gather about 50 to 55 kg pollen within one season. The larger part of this pollen amount will be utilized as food. It means that there still remains a good reserve which the beekeeper may use without violating the nutritional balance of his bees, which is frequently the case when excess honey is withdrawn from the bees' nests.

To collect the pollen pellets, one uses pollen traps. Such traps differ in their design. Most frequently used are those installed near the flight entrance and near the bottom of the hive. The most important component of a pollen trap is its pollen-collecting grid. As a rule, it is made of plastic. Its holes are round, being 4.9 to 5 mm in diameter. On its outward side it is smooth, on its inward side it has fins beneath each row of holes; when entering the hive, the bees step on these fins. The grid is movable. When in its working position, it closes the entrance; when it is idle, the entrance is open.

A pollen trap with a 800 g capacity is equipped with a caprone grate for ventilation.

A pollen trap to be used in front of entrances is hung on the front wall at the entrances to the hive; it is turned on immediately, without any preliminary training of the bees. Within about two or three days the bees will be noticed fussing on a bee board, but then they will gradually get used to the new obstacle which suddenly appeared in their way to the hive, and will start their normal work. The device should be attached to the hive very firmly so there is no slit. The hole cut for the drones and the upper entrance, if it is open, must be carefully closed at this time. Under these conditions the only way to the hive and from the hive will be through the pollen trap. When the bees resume their normal work, the hole for the drones may be opened again.

Passing through the grid, the bee loses the pollen she carries. The pollen pellets drop onto the grid and down into the pollen trap. Large pollen pellets break off, but when they are small and light, the bee may frequently pass through with them. Thus the bees manage to bring into the nest about 30% of their pollen pellets. Such quantities

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Pollen traps.



A hive with a pollen trap.

of pollen are thought to be sufficient to meet the bees' requirement, though pollen reserves are not accumulated.

The bees get mobilized for a new pollen search when the beekeeper removes the pollen they bring in, and its quantity in the nest gradually decreases. Nature has taught them to live with abundant food supplies; and lacking large stores of food, they begin feeling nervous, logically enlarging their ranks of foraging bees which supply them with a lot of pollen. The flying energy of bees looking for pollen-bearing plants remains high even when the latter produce their pollen very poorly. It was found out that under the same conditions of care and maintenance, a colony will collect more pollen if it has a pollen trap in its hive than a colony which is not equipped with one.

Some apiarists claim that a colony loses 250 g honey per each kilogram of pollen it collects. However, when the honey harvest is not strong but only supports the colony's tonus, the honey yield does not seem to differ much. When the main honey flow begins, the pollen traps are all removed.

Over half of all pollen is gathered during the blossoming of the willow family, the maple, dandelion, buckthorn, raspberry, fruit trees and forbs. The light-yellow pollen pellet from the willows is followed by the orange one from the dandelion which, in its turn, is replaced by the grey-greenish and brick-red pollen pellet from fruit trees. A lot of pollen, chiefly yellow in colour, is gathered by bees from meadow grasses.

Without hindering in any way a colony's growth, its preparation for winter, as well as its honey harvesting, one can obtain from it as much as 6 to 8 kg pollen within one season.

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The pollen brought by the bees is 25 to 30% moist. Its water content depends on the air humidity, which increases if there are frequent rains or the honey flow is high. The bees collecting the honey seem to wet the pollen with nectar much more when forming their pollen pellets. In addition, when the nest is ventilated during the removal of excess water from the nectar, the pollen pellets inside the pollen trap become wet, since pollen is very hygroscopic. To protect pollen against atmospheric precipitation, a broad visor made of wood, plastic or glass, is fixed at some angle to the front wall of the hive, just above the pollen trap.

Since pollen contains many yeast fungi and enzymes which become highly active in any humid and warm medium, it can sour readily. Pollen can spoil even when left in the pollen trap until morning. The first sign indicating the deterioration of pollen is its lumpiness and caking. In view of this, at the end of each day when the bees stop flying, the pollen must be removed from the pollen trap. It is poured into any enameled container (a bucket, a sauce-pan) or wooden boxes. Pollen must not be stored in iron containers because its acids react with metal and form salts harmful to the human organism.

Various foreign bodies can get into pollen, such as flower petals,



Pollen pellets from different plants.



Products of flower pollen.



Out of the solar wax extractor.

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pieces of rubbish, wax plates and brood caps, sometimes there happen to be fragments of bees' wings and legs. Such alien particles are separated from the pure pollen bulk by a weak air jet from the conventional ventilator or vacuum cleaner. All particles can be filtered out easily. The pollen so treated is homogeneous and clean. Now it can be delivered to the reception station. This is usually done on the second or third day after all operations have been completed. To prevent the pollen from any damage during these days, it is stored in a refrigerator, scattered in layers of 2-3 cm thick over shelves, where it is ventilated and dries. With the refrigerator temperature of $+4^{\circ}\text{C}$, the pollen may well be stored for as long as three days, but it is better to bring it to the reception stations even earlier.

Beekeepers engaged in pollen production find it more profitable to deliver it not when it has just been removed from the pollen traps and is still moist, but when it has dried so that the standard moisture level is 20% or even less. The lower the moisture, the less probable is the chance of the pollen's deterioration in quality. To dry the pollen he collects, the beekeeper uses drying chambers equipped with calorifers and ventilators. Such a dryer is equipped with netted griddles, of 1 sq m in size, having caprone or gauze nets, on which fresh pollen is scattered in thin layers (4 kg). Depending on the pollen condition, within 12 to 48 hours its moisture content is lowered to 10-12%. Dryers are equipped with automatic thermoregulators to maintain the air temperature at a level of $40-42^{\circ}\text{C}$. No temperature increase is permissible.

When the pollen is ready, it is immediately packed in polyethylene bags, milk cans, or glassware. It is very important to have the pollen tightly sealed, so that it does not contact the air and absorb its moisture during storage.

Pollen can retain its qualities well when stored mixed with honey or sugar powder. When preserved with honey, the proportion is two parts of honey to one part pollen; when preserved with sugar powder, the proportion of dried pollen is 1 : 1. Pollen so preserved is stored in some dark and cool place.

Pollen is also used to make dough for bees. This dough includes pollen, honey and sugar powder. To prepare 25 kg dough, one takes 5 kg pollen, 2 kg honey and 18 kg sugar powder.

Bearing in mind that pollen is a dietetic and medicinal product, the beekeeper should strictly observe the rules of sanitation and hygiene. The apiary must always be kept meticulously clean; the apiarist himself must regularly visit the doctor for medical examinations; his overalls and his cap must always be clean and neat. The state of one's working place, one's personal hygiene, as well as the

Bees Also Provide Pollen and Royal Jelly

way one maintains the technological regime must be rigorously controlled.

Flasks with royal jelly. To produce royal jelly, one must also have strong bee colonies, large stores of food for his bees, and a good honey harvest. However, the decisive factor for royal jelly production is a special physiological state of the bee colony, namely, its swarming. It is also very important that the beekeeper has large reserves of young bees at this time, since they are capable of secreting great quantities of royal jelly.

It is already in spring that the beekeeper separates from all of his colonies a group of the most vital and strongest bees whose growth he will carefully stimulate in every possible way. Their nests are expanded not with foundation but with empty combs or by honey-poor combs of brown colour which at this time particularly attract queens eagerly laying eggs there. The nest-expansion should not be excessive because it is better if the bees feel rather crowded than enjoy large vacant space. Under such conditions the colonies will sooner complete their growth and their instinct for swarming will be intensified.

Colonies which have seven or eight frames of brood are regarded as ready to yield royal jelly. At this time their queens are taken away (transferred to nuclei). The nests are narrowed, one or two honey-poor and brood-free combs are withdrawn. The bees cannot live in such nests and go beyond the diaphragm.

In five or six hours after the queens' removal, the nests receive three grafting frames with larval bees in cups; all these frames are installed at once. All emergency queen cells are destroyed because they hinder the acceptance of grafted larvae. The frames are alternated with brooding combs. To maintain the colony's activity, it is fed small portions of honey food. It was found that such a one-time supply of large quantities of larvae does not decrease but, on the contrary, increase the number of larvae to be reared as queens.

At first, colonies receive 180 larvae (60 per frame); then, when the colonies gain force, they will get 240 queen larvae (80 per each frame).

Pharmaceutical factories accept royal jelly only when it is three days old. To obtain such royal jelly, the following method is employed: at first, the grafting frames with queen cells are installed in hives marked 1, then—in those marked 2, and on the third day—in hives marked 3. At the end of three days, the grafting frames are removed in sequence from each group of colonies, the bees are carefully swept off the queen cells. The frames are put into some portable

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box and carried to the laboratory specially equipped for the purpose. Then one carefully removes first one frame and puts it flat on a piece of oilcloth; the planks of the frame are turned with their open queen cells upward; the latter are cut in half by using a scalpel or a sharp blade, and their larvae are removed by a sterile glass spatula.

In this way one prepares all the frames. Then, by using a spatula, the beekeeper takes the royal jelly from each queen cell and puts it into a dark sterilized glass flask. Upon its complete filling, the flask is sealed tightly with a screwed-on stopper which is wax-covered from the inside.

Before and after it is filled with royal jelly the flask is weighed and labelled. Its label shows the date of the honey harvest, the weight of the royal jelly and of the container, as well as the name of the beekeeper.

Royal jelly is never mixed with adsorbents. It is stored in a refrigerator at 0, +1 °C. Under the same thermal conditions it is transported to the reception station or to the pharmaceutical factory.

There are numerous factors affecting the quantity of royal jelly in the queen cells. In the first place, the latter is badly dependent on the age of the grafting larvae. If a larva is older than one day, it will eat much more food within three days than a younger larva. However, if a larva is very young, say, just born, the bees will not give it too much food either, though for its young age this amount of food will be quite sufficient.

There is always more jelly in queen cells which are grafted with larvae who are 10 to 15 hours old.

The technology of larval grafting for queen rearing is the same as for artificial queen rearing. Nevertheless, it was found that the same colony-donor does not always accept the same number of larvae to be queen reared. Its first acceptance embraces only 50% or somewhat higher, the second and third acceptance will already include two thirds of the larvae, and those to follow will take 85 to 90% of accepted larvae, and even more.

By removing the frames with three-day-old royal jelly and replacing them with new ones, the beekeeper breaks all emergency queen cells out again.

Later on, despite the fact that the queenless rearing colony goes on rearing new queens, drone-breeding bees will come into being there. They will appear because the queen has been absent for too long. Drone-breeding bees hinder severely the production of royal jelly in the colony, since the latter will accept fewer larvae and will feed them much worse.

There will be no laying bees in the colony if the nest periodically receives frames with young larvae, and, to replenish the bee reserves, supplying royal jelly, combs of mature brood. All excess frames are taken away, so as to keep the nest constantly crowded.

By regular rejuvenation and strengthening of rearing colony, one can artificially maintain their ability to raise large quantities of queen larvae. Each colony may be used for royal jelly production for at least three months.

The Summer of Beekeeping Is Over.

The Instinct of Reproduction Awakens Again



he time when nectar plants bloom abundantly is over. The bee colonies have worked hard, preparing their food for winter, have worn out, and their ranks have greatly thinned out. The nests are now rather poor in brood. During the main honey harvest, especially when it was strong and there were not enough combs for storing honey, the bees accumulated the honey in their nests, pouring it into brood-free cells. Due to all this, the queens didn't have enough space to lay their eggs.

As compared to what they were like at the onset of the honey flow, the colonies have changed greatly. It is true that if the colonies were not very strong at that time but continued to grow, by the end of the honey harvest they did not get much weaker. This also pertains to colonies living in areas with poor and long honey harvests during which the queens were actively engaged in their egg-laying. Both the former and the latter colonies have come out of the honey harvest much stronger and have reared a lot of brood. But now, with the honey harvest over, their physiological state is changing. As the main honey flow decreases, the intensity of the instinct of food accumulation diminishes. As soon as the bees feel the approaching end of the honey harvest, their instinct to protect their accumulated food stores gains power and might. It was quite recently that, bringing abundant amounts of nectar into their nests, the bees never bothered to guard the entrances. Now all flight entrances are strictly watched by special guards. Excessively broad entrances are now carefully narrowed by the bees with their propolis. All aspects of bees' behaviour now demonstrate their alarm, nervousness and excited concern.

Their flights are much less intense now. One can easily see that the summer of beekeeping has come to an end.

As soon as the main honey flow is over (the flow from forbs and buckwheat is decreasing gradually, that from linden ceases in just one day), the bees immediately start throwing the drone brood out and

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mercilessly expell the drones from the hives. First, they push the drones off from the honey combs to the empty ones, watching them strictly so that the drones do not return to the food stores. When the drones get weakened from hunger, the bees kick them out of the nest onto the bottom and walls of the hive. Those which are completely weak are drawn out of the hive into the open air. The drones frequently manage to escape from the tight mandibles of the bees and to fly up into the air. But when they try to return to the nest, the guard bees never let them in. However, the bees do not use their stings against the drones. Towards nighttime, the front walls of the hives, as well as the earth beneath the flight boards are covered by small groups of drones weakened and numbed by the cold.

How striking their reaction is to the changed conditions in nature! Such merciless treatment of drones, which are the bees' natural brothers, that quite recently they were so carefully rearing and paying so much attention to, is biologically justified. No males, as stock-producers, are now wanted in the colony: the time of swarming is long over, the young queens have all been fertilized. This is the thing that determines the bees' attitude towards the drones. In addition, the latter are now absolutely useless for doing any jobs in the nest. And each of them consumes several times more food than one bee does.

This kind of behaviour in the colony is a result of the manifestation and sharpening of the bees' instinct of food accumulation. No matter how large their food reserves are, the instinct of saving and rational food use becomes very acute in every bee colony. All bees live for the future which, in the first place, depends on their food supply.

When the main honey harvest is over, the instinct of reproduction again governs the colonies' life. They begin to pay more attention to and take greater care of the queen; they remove the uncapped honey from the middle of the nest to rear brood there.

The bees, remaining in the nest after their hard work at the main honey harvest, are now living their last days, and the colony is doing its best to rejuvenate itself. But its future does not depend on the youth of its members alone, it is equally determined by their numbers. To be able to tolerate all hardships of the winter season, especially in areas where it lasts long and is severe, the colony hurries up to rear beforehand as many new generations as it can within the short time before the cold weather begins.

Thus, after the end of the main honey flow the colony is driven by its sharpened instincts of nest protection, food accumulation and reproduction. The instinct of nest protection does not rule the colony for a long time, but only while it is threatened by robber bees, though the bees watch and guard their flight entrances carefully day and

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night. The effect of the instinct of food accumulation is stronger when the stores of food are smaller in the nest and the nectar secretion of the last sources of honey flow is weaker. This instinct may sometimes govern the entire life of the colony and, carefully saving the last remains of the food it still has available in its nest, the colony may stop its brood-rearing in order not to starve in the future. If the food reserves in the nest are abundant, and, above all, nature continues to supply the bees with nectar, the instinct that will now dominate will be that of reproduction, in other words, of accumulating new reserves of bees for the coming winter.

Only such colonies can prepare well for winter whose activity in autumn is driven by the instinct of reproduction. The aim of practical beekeeping is to encourage this very instinct.

It was found that bees living in winter-free zones also react to the seasonal variations of natural conditions. They also feel the rhythm of nature. In South Asia, in particular in India and Pakistan where the climate is tropical, by the onset of the dry season when the plants defoliate, the activity of bee colonies fades, like it does in bee colonies of mid-latitudes when they prepare for winter. It will be interesting for the beekeepers living in the south to learn about this amazing property of honeybees to be able to adapt themselves to long-lasting low temperatures, thus having preserved their species for many millions of years.

The bees reconstruct their nest. During the period of spring and summer the bee nest changes radically. During this time, at least five generations of bees have been born there. The combs, which were brown in early spring, have turned black by the autumn and have become of little use for brood-rearing in the future. Next to these, there may happen to be combs which did not house a single generation of bees. As to new combs, the colony might build them only before the main honey flow or during it, and therefore the queen had no time yet to lay her eggs there. She will not lay her eggs there now, in autumn either, like she did not do in early spring. The bulk of the nest area may now be filled with honey and beebread (which is usually the case in colonies kept in tight hives during the main honey harvest), or on the contrary, the beebread stores may be minimal.

During the main honey harvest, the colonies get weakened and the nests frequently become too large. Each and every of these factors, and all of them taken together, if not eliminated timely, will hinder the work of the queen, and the colony will not be able to prepare well for winter.

At this time of the season the area of the bee nest can be regarded

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normal if the colony can occupy it completely and even feel somewhat crowded. When the flying bees die off, the nest will not be so crowded. If colonies live in multiple-storey hives and occupy three storeys, one of the latter, most frequently the lower one, which is often overfilled with beebread and free of honey, is removed. If the remaining two storeys are light in weight, the hive receives a storey with honey prepared for winter, which is usually installed on its top.

Weaker colonies (nuclei) are usually supplied with a storey and a magazine or two storeys: the lower ones will accommodate the brood, the upper ones (storeys or magazines) will house the honey.

The nests of bees living in long hives are restructured: combs of honey are inserted on their edges, next to them are placed combs of honey and beebread, the middle of the nest is packed with brown and light-brown combs containing 1 to 1.5 kg honey. The number of combs supplied to the nest depends on the colony's might and the forecasts of the late supporting honey flow. A removable board is put inside the nest to separate it from the free area of the hive, then it is warmed up by means of a mat or quilt.

Strong colonies kept in 12-frame hives each receive a magazine with capped honey. If one failed to prepare such magazines beforehand, the nests are assembled in the same way as those in long hives.

If there are large stores of food in the nest, the bees' instinct for food saving does not intensify, the room for brood-rearing in such nests is sufficiently spacious and the queens lay many eggs. With such arrangement of the nest, the food in the magazines remains intact, and whatever food the bees need for themselves and the brood they take from the nest, primarily from its middle.

If after the main honey flow the beekeeper travels with his bees to an area of autumn nectar plants which will supply them with a late supporting honey harvest, they will be able to gather in one day as much honey as they consume within twenty four hours, or even slightly more (the records in the control hive show honey consumption to fluctuate between 0 and 100-200 g). In such cases the nest volume is not changed and the food magazines are not removed. In the regions of the Far East, Central Asia and the North-West the bees can collect even commercial honey from late nectar plants. Under such conditions of a good honey harvest, the food magazines or storeys with bee food receive an additional storey or magazine with empty combs.

Queens lay eggs in autumn only when the food reserves are sufficient.

There is nothing to activate the queens' work as much as a natural honey flow, even though it may be very small. Then the colony works

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at its maximum capacity and utterly enjoys life. However, a small autumn honey harvest can so strongly affect the activity only of such colonies which managed to store much honey and beebread. And this is very natural, because nature has provided its bees, living wild and free, with abundant food inside their own nests.

Practice has shown that in spring queens go on laying eggs, although not as intensely as in summer, even when their food stores are minimal (5 to 7 kg) and the weather may be no good for honey gathering. In autumn, on the other hand, despite considerably greater stores of food available in the hives (12 to 15 kg), they stop their egg-laying long before the cold weather begins.

Constantly depending on the vegetable kingdom, the honeybees have developed an amazing property over the course of their evolution: they can immediately respond to the minute changes in nature. In spring, every new day more flowers and plants burst into bloom. Honeybees, undoubtedly, feel this bloom of nature and live as if in hope for the future which will not leave them foodless. At the end of summer, when most plants have already passed their stage of blossoming, and late-flowering plants are reduced in number, bees can only rely on their own stores of food which they have managed to procure. But since they will have to live through a honeyless autumn and a cold winter, they begin using their food very rationally, the more carefully saving it, the smaller its stores are. That is why the colonies having insufficient honey stores usually terminate their brood-rearing rather early.

Stores of beebread are also very important for bees. They need it not only for preparing food for larvae but also to feed the nurse bees as well. It was found that the organism of autumn bees, constantly reared on beebread, weighs much more, contains more protein and other vital substances, and is much more viable in general. Such bees can more easily tolerate cold and durable winters, their life span is longer, they rear much more brood in spring.

Large food stores procured in autumn guarantee high honey harvests in the future season.

Taking into account this acute reaction of honeybees to their food stores, experienced and keen beekeepers do not remove the honey magazines from the hives after the main honey flow is over. On the contrary, they try to locate their apiaries as close as possible to the sources of late-summer or autumn supporting honey flows. With this method of beekeeping, the bees' instinct of reproduction becomes sharpened; the queens, even those of the previous year, go on laying eggs very intensely. Queens born this year can work well and long even when there is no good honey flow in autumn but the food stores

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in the nests are abundant. In such cases colonies seem to become independent of nature.

If the queens were born last year and there is no honey flow in nature at the moment, the queens' activity is maintained artificially by providing them with small quantities of honey food or sugar syrup regularly. All measures of precaution should be taken against possible attacks of robber bees. Emergency feedings will be ineffective if they are conducted some days after the queens cease their work.

The deficiency of honey supplies are replenished and poor honey stores are replaced by good ones. One of the most serious problems the beekeeper has to solve in autumn is his concern about the food for his bees. *Food is the foundation for the entire wintering season.* If the season of honey harvest is no good (the summer was dry or, on the contrary, wet and cold), then the bees fail to yield commercial honey; moreover, they cannot even store food for winter. Under such conditions one has to feed his bees on sugar syrup. The latter is prepared in the following way: one kilogram of sugar is dissolved in one liter of boiling water; the solution is cooled up to 35-40 °C and fed to the bees in feeders during the night. Syrup of medium thickness was found to be better fermented by the bees and not to crystallize in the combs.

The bees carry the syrup to their nest, extract all excess moisture from it, enrich it with enzymes. Due to the latter, the bulk of complex cane sugar turns into simple sugars, namely into glucose and fructose. In about a day food is supplied to the bees for the second time; the procedure goes on until the food stores in the nest become normal.

Almost all members of the colony take part in processing the sugar syrup, and thus the colony's tonus heightens greatly. The bees seem to enjoy the illusion of a sudden rich honey harvest. They sharply increase their flights and try to find a real honey flow in nature. The queens' egg-laying also increases. When artificially fed in autumn, the instinct of reproduction is sharpened, and in this way one can raise more young bees for the coming winter. However, since the syrup is always given to bees in large doses (4-5 kg per one colony), the bees first store it in the empty combs of the brooding nest. Therefore the daily egg-laying of the queens, under such conditions, may not grow but, on the contrary, it may even diminish. Replenishing the artificial food will not hinder the queens' work, if one administers one half of a normal dose every day.

In processing the syrup, the bees spend a lot of their energy and get worn out (even their wax glands start functioning now). In view of this, emergency feeding should be initiated as early as possible (in the temperate zone, the feeding time should be never later than the second

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week of August), while the summer flying bees still live in the colony. They have done their job well, the days of their lives are now numbered, and they will not be able to tolerate the coming winter. It is these very bees which must be compelled to work with the syrup. If the emergency feeding is effected later, the syrup processing will inevitably attract young bees born in August, which are actually the foundation of the future colony. And their participation in this hard work is no desirable at all.

Besides getting extremely worn out physically, the August bees will greatly exhaust their reserve substances such as fat, protein, glycogen, which provide them with energy and which they will so badly need during their prolonged winter rest. Though emergency feedings do replenish the food stores in the nest, they do not improve the quality of the newly born bees and of the colony as a whole. Particularly adverse is the effect of autumn feeding with sugar on varroaosis-infected bees. Stricken by this disease, bees usually lose a lot of protein, and they lose still more due to the emergency sugar feeding. In such cases the disease turns into a vast infection killing huge masses of bees in winter and early spring.

One has to supply his bees with sugar syrup when the food stores prepared by the bees for winter prove to be of low quality. In the south, bees often bring into their hives the juice of broken watermelons, or of those which are overripen and cracked. They also collect fruits of pears, plums and grapes damaged by wasps. Bees living in forests gather honeydew. They are eager to lick it up, especially on days when there is no nectar flow in nature or it is very poor.

Fruit and berry juices, and particularly honeydew are harmful to the bees. They chiefly contain complex sugars, such as saccharose, melezitose, galactose.

When affected by the enzyme of invertase, saccharose decomposes into sugars which are easily absorbed by the bee's organism. These easy-to-absorb sugars are grape and fruit ones; melezitose does not undergo any changes. It is not affected by another bee enzyme either, namely by diastase, which also takes part in the decomposition of complex sugars. This fact can, to some extent, explain why the bees cannot digest well the honeydew and why their stomach gets overloaded with undigested food. Furthermore, honeydew contains many compounds of the dextrin type, numerous mineral salts, and toxic substances. When the bees are fed on honeydew honey in winter, their stomachs get upset, there are cases of dysentery and of general fatigue, and as a result, the bees may perish in large quantities. However, it was found out that such unfavourable consequences occur not always and not in every colony.

The Summer of Beekeeping Is Over

It is common knowledge that wild bees rather frequently have to spend their winters by eating honey mixed with honeydew, and very often they have to consume pure honeydew alone. History has provided evidence that the beekeepers of the past did not find in the bee trees any traces of dysentery, neither on their walls nor on the combs. Thus, one can suggest that the organism of wild bees, which were undoubtedly healthy, was not adversely affected by honeydew or its effect was never harmful for wild bees. This idea is supported by experimental data of the present-day science of apiculture. C. L. Farrar, in particular, states that healthy bee colonies can well pass their wintering season when fed on honeydew, if their stores of beebread are sufficient, while bees infected with nosema disease under such conditions become heavily weakened and finally perish.

Because nosema disease is so widespread, it has become necessary to remove all honeydew honey from nests and to replace it by flower honey or by sugar.

It is highly undesirable to feed bees on honeydew honey in late summer when they are engaged in rearing new generations for wintering. Weakened bees will never be able to raise healthy offspring.

Honeydew usually appears during a hot and dry summer and a dry autumn. Such weather conditions are most favourable for the growth of aphid, jumping plant lice and suckers and other (Hemiptera order) true bugs. The latter live as parasites on the leaves and young shoots of the white willow, oak, linden, conifers, and fruit trees.

Leaves with a glittering surface, which look as if they are varnished, usually testify that honeydew has appeared in nature. Even the grass beneath such trees may be sprayed with drops of honeydew. In the morning hours, when honeydew has not yet thickened in the sun light, one can see bees working on the leaves of trees and beneath the trees on the grass.

It is not difficult to determine the presence of honeydew inside the hive either. The colour of honeydew honey is more often dark, with a slightly greenish shade; some types of honeydew make the honey look smoky-gray, and thus it can be distinguished from pure natural honey (of buckwheat, heather, chestnut). Honeydew honey is thicker, more viscous. Even small drops of honeydew to natural honey change the latter's aroma and taste. One can definitely confirm the presence of honeydew in the nest by using any of the widely practiced tests (lime, alcohol, acetic acid).

When the reaction is positive, it is important to learn how much honeydew there is in the honey. If the amount of honeydew is insignificant, it will not badly affect the wintering conditions for the bees, provided the nest will be well ventilated; when there is a lot of

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Bees collecting honeydew.



Collecting propolis.



A bee piling propolis.

honeydew and the air-exchange in the nest is poor, severe consequences are inevitable.

To determine the degree of danger in feeding the bees on the honeydew, it is sent to the nearest veterinary-bacteriological laboratory to be examined. The honeydew honey to be tested is withdrawn from different parts of the combs, including the



Now the bees do not need the drones anymore.

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capped cells. It is poured into a test tube, stirred, and stoppered firmly. The tube is labelled with the number of the bee colony from which it was taken.

To replenish the winter stores of honey with sugar, as well as to replace the honey of poor quality by sugar, they are emergency measures which can be taken when absolutely necessary. It was found that any disturbances in animals' nutrition diminish their enzymic activity, weaken the defenses of the organism, and bring about various pathological changes.

When bees are fed on impoverished food (sugar), and especially when such feeding lasts a long time, their functional activity is negatively affected, they winter more poorly, and their productivity greatly reduces.

One may think that his bees have wintered well because there are no signs of dysentery in the hive. In fact, due to such artificial feeding (with sugar), the bees' organism wears out so much that in spring they will not be able to function as good nurses or foragers. As compared to those which were receiving natural honey all winter through, the life span of artificially fed bees is considerably shorter.

If bee colonies spend their winter eating sugar syrup, they will grow very slowly in spring and will gather significantly less honey. Thus, the beekeepers' hopes to gain additional profits by substituting the natural honey for feeding with sugar are not justified.

Winter feeding of bees on artificial fodder can be improved if this fodder is prepared not of pure sugar but with the addition of one portion of honey. Honey will alter the quality of artificial fodder, accelerate the process of inversion, and facilitate the bees' task of processing the syrup.

In such cases the beekeeper should pay more attention not to the sugar he uses but to the honey, of which it never hurts to have reserve supplies. It was as far back as 1893 when the Congress of Russian apiarists passed its resolution on the bee fodder to the effect that comb honey should always be regarded as the best bee food in winter. Honey mixed with sugar was considered to be of secondary importance, and sugar syrup was qualified as the lowest quality food to be used only in cases of extraordinary emergency.

In autumn, this year's queens continue to lay eggs much longer. The growth of the colony in autumn greatly depends on the quality of its queen. It was noticed that queens which participated actively in preparing the colonies for the main honey harvest lay considerably fewer eggs in autumn and terminate their egg-laying some two or three weeks before the queens which were reared right before the main

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honey flow or during it. The latter, naturally, by that time have not yet gotten tired, they are full of energy, and it is practically only after the end of the main honey flow that they begin gaining force and speed. Particularly few eggs are laid in autumn by the previous year's queens whose colonies were kept in multiple-storey hives. The design of these hives and the beekeeping technology provide such conditions which compel bees and queens to work at maximum capacity.

Colonies with young queens of two or three months in age raise many more bees for winter than those having one-year-old queens, and especially queens which are two or three years old.

Queens which were not replaced on time will cease egg-laying very early, and it is not always possible to compel them to lay eggs again. Their ovaries rapidly diminish in size. Therefore it is very important to see that the queens do not stop working ahead of the proper time.

The instinct of reproduction in such colonies can be maintained and sharpened by creating for them the conditions of a honey flow or by regular supplementary emergency feeding (0.5 liter of liquid fodder per colony daily). The feeding is initiated right after the end of the supporting honey flow, it should last at least 10 days. To rear as many bees for winter as possible, queens must be laying eggs for at least four weeks. When a queen lays 800 to 1000 eggs daily (they can lay even more eggs), the weight of young bees in the colony may increase by 2 to 2.5 kg during this time. The total weight of the colony by the onset of winter may reach 3 kg. Such colonies may be regarded as ideal and be used as a standard for all colonies entering winter. Such colonies guarantee that the apiary will be highly productive the following year and that the colony will winter very well.

In northern areas where the cold weather sets in early (in August), the queens usually work for less than four weeks after the main honey harvest. Within such a brief time the colonies fail to feed the necessary amount of young bees. In these regions the flight-free period lasts over seven months, and to utilize the honey season well, the local bee colonies must always be strong. In addition, such territories are known for their early spring honey flow from the willow family. So, it is especially vital for beekeepers in these regions to provide the necessary conditions for the growth of their bees on time, and above all, to see that their colonies have young and highly fertile queens after the main honey flow.

There are apiaries where in autumn the bees were reared with the help of the second queens which were rejected and substituted later or used to raise additional bee reserves by the two-queen method. In such apiaries the nuclei are added to the principal colonies after the growth period to make them stronger.

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At this time, all poor colonies and those of low productivity which have exhausted their strength in their hard work during the honey harvest and failed to gain their strength back before the autumn began, likewise all nuclei which have not matured, or late swarms, all of them are eliminated (they are either joined by twos or threes or added to other colonies of greater strength). To leave such weak colonies for winter is not economically practical. "Two or three united colonies," Academician A. M. Butlerov wrote, "can provide quite a reliable hive for winter, while each of them taken apart, being weak, would either perish in winter or come out of it in spring almost dead. For the sake of his own profits, the beekeeper should never permit unreliable colonies to enter winter. It is much more profitable to unite the unreliable colonies into one reliable colony and to enjoy its power in spring, rather than to lose all unreliable colonies completely."

Before the colonies are eliminated as individual ones and are united, the queens in such colonies are found and killed.

The bees gather in a cluster. So, the summer is over. It has become markedly cooler. The grasses have faded in colour, the leaves on the birch and the linden have turned golden, the air is breathing the smell of autumn. In the morning and towards the end of the day there are no bees at the flight entrances. It is only on warm and bright days that the apiary is alive again, but even within these hours its revival is but too short. Bees are very rarely seen on autumn flowers. The queens have ceased their egg-laying, but there is still some capped brood in the nests and the last generations of bees are now completing their maturation. Here, around the brood, the number of bees is much greater. They get into the hottest part of the nest to feel warmer. They are driven to this centre of the nest from the terminal combs where the temperature is very cold during the night and early morning. It is this very time when the beekeeper begins preparing his bees for winter.

Wild honeybees arrange their food in the nest in such a way that they can always reach it easily, especially in winter.

The Middle-Russian and Italian bees are known to place their honey, ripened or unripened, above the brooding part of the nest. During a strong honey flow, trying to save their time and to locate their nectar over a larger area so that its moisture evaporates faster, they first store it below, in any vacant comb, even in those being vacated by the brood. Later, in thickening the nectar and fermenting it, they can frequently bring the nectar upward, even on the same night. Grey mountain Caucasian bees, on the contrary, when the honey flow is strong or even medium, will put their honey in the mid-

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dle of the nest and will never hurry to carry it to the magazines. In this way, they virtually prevent the queen from working. It is only at the end of the honey flow that they remove the honey from the middle of the nest and thus permit the queen to work there. Closer to autumn, bees of all breeds often carry the honey from the combs at the edges of the nest into its centre if the honey stores there are not large enough.

Bees never put their honey into combs adjacent to the flight entrance. This part of the nest has the best conditions for rearing the brood. After the combs have been freed of it, the colony uses these combs to place its winter cluster there. In this way, the position of the entrance is of great importance for providing favourable conditions for the bees' wintering. This biological characteristic is sometimes underestimated, unfortunately, and some beekeepers change the place of the entrance at such a time when his bees already cannot get used to it and adapt to it so as to redistribute the honey properly.

This clustering space is formed in such a way that it could steadily have fresh air rich in oxygen; at the same time, it should be located within easy reach of the entrance. As a rule, it happens to be near the lower entrance, since the upper ones are usually closed after the main honey flow. If the beekeeper firmly closes the lower entrance in winter and opens the upper one in the same or in another storey, the colony will be unprepared for the resulting conditions. Then its wintering will be more difficult.

The clustering space, created near the lower entrance, may prove to be not spacious enough, especially if the nest is tight and the colony is strong. Then the larger part of the bee cluster will have to settle down on honey combs, and this is highly undesirable. If the beekeeper timely opens the upper entrance in the same storey, too, the colony will form its clustering space with regards for this entrance. In this case, the clustering space will be not only more spacious but it will be nearer to the main winter reserves of food, so that the cluster could now live under steady food conditions which it will be able to enjoy beginning in autumn. The conditions for the colony's wintering are now the best possible.

In the nest of wild bees, when it is finally prepared for wintering, the main stores of food are piled on the top, and large bits of it are arranged at the sides of the nest. The combs in the middle of the nest and close to the flight entrance are usually empty. And it is in these very combs where the wild honeybees gather in their cluster, occupying some of the honey combs, too.

When the weather is still warm, the bees scatter about the entire nest. But as soon as the air outside cools down to 12-13 °C, they begin

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flocking together into a dense mass, and soon form their winter cluster. The number of bees in the hive streets increases. The streets are not only more packed with bees now, but the bees are filling in every vacant cell. After that the cluster becomes very compact. Now it is not a layer of combs filled with food and brood that separates one hive street from another, as was the case quite recently, but only the mid-ribs of empty combs, the cell bottoms. With this distribution of bees in the clustering space their cluster becomes integrated and monolithic, with a nucleus in its middle where the temperature is always higher and where the queen usually prefers to live.

The spherical shape of the cluster is absolutely perfect; it is very convenient because the honey is accessible to the bees in any hive street, and is near them. The path covered by the bee from the middle of the street to the honey is the shortest, it is equal not to the cluster diameter but only to its radius.

The wild bees' winter nest is a model of rational nest arrangement in the hive. Taking into account the biological capability of wild bees to arrange their honey in the nest in a spherical pattern and to gather in their cluster on empty combs, the beekeepers began arranging the nests of their bees in frame hives in the same way.

As a rule, when kept in multiple-storey hives, bees by the onset of winter preparations occupy three storeys. The two lower ones are used by each colony to rear its brood, and the upper one is meant to store the food. When the brood is ready, the lower storey usually remains almost empty (there still may be small sections with capped honey in the combs near the edges). Now the lower storey is removed. Since there are many bees there, while the queen is usually in the middle storey, the lower one is transferred upward, toward the ceiling which is preliminarily equipped with a bee escape. The top storey is covered with a reserve ceiling and then roofed up. The bees from the upper storey will enter the nest through the bee escape. Twenty four hours later the storey with its empty combs is taken away for long storage. If there is no special device for removing the bees, they are carefully brushed off of the combs onto the nest, which is equipped beforehand with an empty magazine, or onto a ramp in front of the flight entrance. In the previous middle storey, where the colony reared its last generations of bees and which is now installed on its bottom, the combs are much better filled with honey and beebread than in the lower one. The food there is chiefly located in the edge frames.

During the autumn brood rearing, the honey stores in the upper storeys can get depleted; sometimes bees also put autumn honeydew

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there. These storeys should be substituted by others which contain a lot of good quality honey.

It is in this state that the nest will be good for winter. Like in a natural one, there is a clustering space here and abundant food reserves above it. The bee cluster in such a nest runs not along a horizontal line (from the front wall to the back one), as is the case in all single-storey hives, but along a vertical line (from bottom to top), as it naturally does in a tree hollow. A two-stage nest is closer to a natural one also because, owing to the space between the frames of the lower and upper storeys, the bees can pass easily from one street to another, or from the periphery of the cluster into its centre. The passes and labyrinths typical for the nests of wild bees, which permit them to move freely inside their cluster, are replaced by the inter-storey space in this type of nest.

Weak colonies can winter well when their nests receive food magazines instead of honey storeys.

If bees are kept in one storey of a 12-frame hive or a long one, the beekeeper installs at the edges of their nest such frames which are mostly filled with honey (3.5 to 4 kg), and next to them some frames with honey and beebread (they weigh slightly less), followed by combs with at least 2.5 kg honey. The centre of the nest, depending on the strength of the colony, is completed by three to five combs of light-brown colour; they are only half filled with honey. This nest arrangement is known as bilateral (or a dome): on both sides of the nest, spreading out from its centre, there are equal amounts of food which are quite sufficient to support the bees well during the winter.

There are other ways to arrange nests: the food reserves are distributed evenly, in the shape of a barb, or unilaterally. All these methods are based on food shortage and do not take into account the particular ways in which the bees arrange their food stores in their winter nest (a tree hollow, or a hive) themselves.

Particularly unnatural is the barb arrangement of a winter nest. With this technique, the heaviest comb filled with the most honey is inserted in the middle, against the flight entrance; on both of its sides combs with gradually decreasing quantities of food are placed. In such a nest the main stores of food happen to be not above the bee cluster or on its sides, but directly inside it. The unnaturalness of this technique lies in the fact that it deprives the bees of their clustering space and compels them to settle chiefly on the honey combs. The wedge of honey, cut in the very core of the cluster, divides the colony into two parts, depriving one of them of its queen. The nucleus of the cluster, following this technique, is now not in the middle part, which

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is the warmest area in the nest, but in one of its halves where the queen settles down. The bees, in the periphery of the cluster, suffer from a shortage of honey.

With a unilateral nest arrangement, the stores of honey usually increase towards one of the lateral sides (it is usually the south-eastern one). The cluster under such conditions is often formed not on the combs containing the largest quantities of honey or near them, but on those in front of the flight entrance, though their content of honey is low, since the queen worked on these combs and the autumn brood was reared there.

The cluster, moving from bottom to top along the hive streets, has no energy to shift sideways, and therefore, having depleted all their food stores, the bees may perish from hunger, despite the fact that the food on one side of the nest remains untouched.

Beekeepers using this method also have to examine their colonies in late autumn when the days are still bright enough and they can disassemble their nests. If they find a bee cluster formed on the nest's side having little honey, they move some of the bee-free honey combs from the opposite side closer to the cluster.

Sometimes, however ridiculous it may seem, poor wintering can be attributed to the abundance of honey in the nest. To support this view, some beekeepers cite facts when the bees' wintering was quite successful with food stores of 12 to 14 kg and was a complete failure with food reserves of 25 to 30 kg. Indeed, such things may happen occasionally.

In hives with 435×300 mm frames, large quantities of food are distributed on a rather limited number of combs. If one imagines that all food quantities (25 to 30 kg) are distributed evenly over all combs, then on the average, each comb will have about 2 to 2.5 kg honey. Such frames have very few empty cells; the nest is almost devoid of the natural bee clustering space. The bulk of the bees have to settle over the honey, though it absolutely contradicts their nature.

Under natural conditions, owing to a heavy honey flow, the nest of wild bees has little room to form their cluster on empty combs. Some bees, finding no place within the clustering space, prefer to settle not on the top, i. e. on the honey combs, but on the bottom, beneath the empty ones, hanging down like a huge bunch, as is typical for a swarm. In a 12-frame hive and in a long one the subframe space is very small and the bees there are unable to do this.

In such hives the cluster streets are divided not by the midribs as in clusters located on empty combs, but by whole layers of honey. Each such cluster street lives its own independent life. Therefore the bees

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have to consume considerably more honey than do the bees in the clusters built on empty combs. And the former have to spend more energy, they wear out much sooner.

When the food stores in the nest are not huge, a natural clustering space forms where the cluster lives in winter. But, sooner or later, the instinct of food saving will intensify in the bees and they will begin starving. If they manage to survive through winter, they still will not live long in spring and will not be able to rear a lot of brood.

So, colonies which live in nests arranged without proper consideration taken of the way wild bees store food in their natural dwellings will come out of their wintering with many bees dead or physically weakened; and frequently they may perish completely. A properly arranged spacious nest with large stores of honey and beebread will guarantee that the bees winter well.

When one uses food adapters (hive storeys are used as deep adapters, magazines—as shallow ones), one does not assemble or reduce the nests of the bees. *To diminish the nest to such a size which the bees can settle on is a mistake, and it is often impossible to rectify since it contradicts the very nature of bees.* The only important thing is to install the honey adapters on 12-frame and multiple-storey hives not after all the bees gather in their cluster but much earlier, so that they can timely redistribute the honey in the nest in any way they please. Neither should one assemble the nests for colonies which received large quantities of sugar syrup to replenish their honey stores.

When the nests are completely prepared for winter, they are warmed up by means of water-permeable quilts (they should preferably be made of sphagnum moss which is hygroscopic and can easily absorb all excess moisture formed in bees' nests in winter, releasing it back into the atmosphere).

In autumn, when there is no honey harvest, bees become unusually excited and irritable. One can hardly open his hive when some alien bees immediately fly to it. It may provoke abundant attacks of robber bees.

Such attacks, like a flame of fire, will quickly spread to involve the neighbouring colonies, and if the beekeeper does not quash it at once, it may involve the entire apiary. Within a very brief time the bees may be deprived of all the honey they have. Therefore in autumn it is safe to open one's hives only when the weather is gloomy and the bees do not fly at all, or late at night; but in any case, one can do it for a very short time, strictly observing all measures of precaution.

So, to raise as many young bees in the colonies after the main honey

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flow as possible, to free these young bees from any jobs in the hive, to arrange abundant stores of top-quality honey above the brooding nests, to create such conditions that best correspond to those enjoyed by bees in nature—all this will guarantee that your bees will tolerate the winter season well. All foundation of successful beekeeping is laid down in autumn. Even the most insignificant mistakes made in autumn turn into serious blunders in winter, and cannot be rectified in spring.

Enjoying Their Winter Rest



It is late autumn. The days have become shorter and cooler. The sun comes out but only for a short while. The air temperature at night drops sharply. The plant kingdom has entered a phase of preparations for the long winter rest. The trees and shrubs shed their yellow leaves, the grasses lose their bright colours, and it is only in a very few places that one can still find flowers which have almost lost all their fragrantcy. These are flowers of the yellow Star-of-Bethlehem (*Gagea lutea*), chicory, meadow knapweed, and other representatives of late autumn flora. On these flowers one can occasionally encounter single bumble-bees, which are used to the cold, and rare solitary bees.

If honeybees ever fly out during these days, their flights are very brief, only to empty their bowels. All other hours of the day, and frequently entire weeks, the bees spend in their nests, they do not even come out onto the flight boards. The combs are now being freed of the last generations of bees. The hives look as if there is nobody inside them. The bees do not even respond to or punish robber wasps penetrating into their nests through the flight entrances and stealing their honey. And it was quite recently that a strict guard watched attentively every entrance of all hives, reliably protecting the food stores procured for winter. Looking at the hive from the outside, one cannot notice any signs showing that inside them, behind the walls and beneath the roofs, there live strong colonies full of energy. What has happened to these colonies? Like the plant kingdom, they have also entered a long and special stage of their life, that of winter rest (dormancy).

Unlike many other species of insects which lead a solitary life, honeybees do not hibernate during winter but enjoy a normal life, they go on eating and responding actively to their environment. But because of the outside cold, they are now unable to leave their nest to empty their stomachs of excrements, as they did it before. Therefore nature has endowed the honeybees with an amazing property which

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no other living being has—they can retain their excrements in their stomachs for a very long time. The bee's rectum is made in such a way that while it is getting filled with food remains undigested by the organism, it can considerably enlarge its volume (by five to seven times) to accommodate over 40 mg excrements, in other words, almost half as much as the bee herself weighs. And her physiological condition does not in any way deteriorate with such an enlargement. The rectal glands secrete some specific substance which prevents any decay processes. When the wintering is normal, the excrements get thicker and more compact while accumulating, their volume decreases, and thus the intestines do not get overloaded.

Nature has provided the honeybees with another adaptive quality of great value—their metabolism is rather slow. During winter they can live well by consuming negligibly small amounts of food. Their honey and beebread were prepared previously by them and processed so as to be easily digested so that now they do not have to spend great efforts on these jobs. Such provisions enable the bees to tolerate severe winters with minimal energy losses.

Sometimes the colony is compelled by the circumstances to spend lots of its energy during its wintering. Such circumstances are practically inevitable, since the bees cannot avoid every kind of disturbance, such as the alarm because of their small food reserves, or elevated temperature in the nest due to its excess warming and insufficient volume; poor air-exchange in the hive, etc. The bees get worn out and are frequently incapable of continuing their existence in spring.

As soon as the autumn cold sets in, especially at night, the honeybees begin gathering over a smaller area of combs than they occupied before. When the hive temperature goes down to 6-8 °C, they gather into a ball-like mass. Each bee individually cannot maintain its constant body temperature, but when many bees join together, they are able to generate enough heat to maintain all their vital functions.

Now there is no more brood in the nests, and in its absence the bees can maintain the nest temperature which may be twice as low as it was before. In the centre of the cluster the temperature is never below 14 °C.

Closely touching one another, the bees warm themselves up. They also release heat by moving inside their cluster. The temperature rapidly increases owing to the friction, and that is why they do not have to spend much food or energy to produce the heat.

The bees create heat inside their cluster which retains it by its outer shell. Depending on the temperature of the outside air, this shell may be thicker or thinner (from 2-3 to 7-8 cm). The size of the bee cluster changes accordingly. The stronger the effect of the outside cold on the

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bees, the more compact and dense the cluster and the less heat it releases into the environment. In this way the adverse effects of temperature fluctuations can be mitigated.

The volume of the cluster decreases because the mass of the bees becomes physically more compact, and also because many bees leave the comb surface for empty cells. When the outside cold gets milder, the cluster loosens, and thus the temperature and gas-exchange inside it can return to their normal levels. The cluster shell on the lower side, which is usually effected by the cold more severely, is always thicker. The upper part of the cluster's shell is the thinnest part, as water vapours and carbon dioxide leave the nest through this part of it.

The heat produced by the bees in their cluster is to a great extent retained in the nest because of the shape of the bees' cluster which the bees have selected during the long course of their evolution. If they did not gather in a cluster, which they form to spend the winter in, but in some other kind of grouping, they might inevitably lose excessive amounts of heat and would thus have to spend much more energy. A ball (a spherical cluster), as compared to any other geometrical figure of the same volume, has a much smaller surface and the area of its contact with the environment is therefore smallest. The heat release of a cluster arranged in the shape of a sphere is usually minimal.

The temperature inside the cluster can be maintained at some more or less definite level not only because of the thickness and density of the shell, but also because there are numerous air chambers there. They are formed directly in the spaces between the bees, and between the bees and the comb walls where the bees live. This amazing property of bee clusters was mentioned long ago by Academician A. M. Butlerov. He wrote: "Owing to their ability to produce heat, the mass of united bees does not easily let it out and retains well in the nest. This is quite clear if one takes into account that here, like in many other masses which poorly conduct heat, there are many tiny spaces filled with air".

As found in numerous investigations, the bees maintain above-freezing temperatures only inside their cluster and on its surface. They do not in any way influence the temperature of their environment, even when it is below freezing. Science and practice have come to the same conclusion: it is not at all necessary to reduce by much the bees' nests for winter, as it was highly recommended in the recent past, neither is it essential to warm the nests on their sides. Warming up the nest excessively does not help the bees conserve their energy; on the contrary, it negatively affects the bees' life since it causes moisture retention. In addition, the bees will not be able to expand their cluster rapidly when the weather suddenly becomes warm for a short while,

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Wintering outdoors.

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when the bees could exploit the warmth for their cleansing flights and for getting closer to their food supplies. It is not accidental that bees can tolerate rather easily long severe winters when their natural homes are spacious and completely unwarmed.

Strong colonies can withstand the cold much better. Their production of heat energy which is so vital for their existence is directly related to their heat loss, in other words, due to the great number of its bees, the cluster's nucleus produces as much heat as it loses through its shell to the environment, irrespective of the latter's temperature. A strong colony has sufficient numbers of bees to produce heat and to retain it in the nest.

This interrelation is violated in a weak colony. The weak colony has to use more bees to provide the protective shell for the cluster than to produce the heat it needs. And, naturally, the smaller part of the colony, involved in heat production, expends three times as much energy. In view of the fact that the individual bees living in the cluster's nucleus constantly replace one another, the colony wears out dramatically during its wintering. Furthermore, higher temperatures were found inside the cluster of weak colonies than inside the large cluster of strong colonies. To maintain such elevated temperatures inside the cluster, weak colonies must expend more energy. It was N. M. Vitvitsky who pointed out long ago that "...bees are not afraid of winter cold if there is plenty of honey and a lot of hale and hearty bees in their nest."

A world authority on bees, L. Langstroth, said in this connection that even the lowest temperatures in bees' habitats cannot destroy a strong bee colony if it has sufficient quantities of honey.

The species of honeybees has developed and been perfected under the most severe conditions of constant natural selection. While settling over the Earth and encountering new habitats which often differed greatly from those they had inhabited before, the honeybees had to adapt themselves involuntarily to the new environment. In this way they have elaborated such valuable biological properties as high cold-resistance, owing to which they can tolerate low temperatures, and winter-resistance, permitting them to withstand unfavourable conditions (long wintering, temperature fluctuations and fluctuations in the air humidity). These properties have become hereditary and are determined by the bees' genes which transmit them from generation to generation.

Thanks to their collective thermoregulation, which is a highly effective way for maintaining body temperature, the honeybees can endure severe and long winters.

Wild bees living in wood cavities and mountain crevices have

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the opportunity to use to their advantage every warm day of quiet late autumn and even of winter to empty their bowels. Hunters have frequently seen wild bees flying around sunlit places even when the weather was slightly frosty.

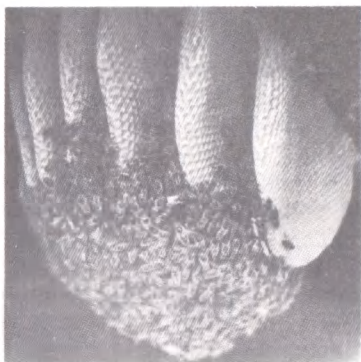
The body temperature of bees is not constant and depends on the temperature of the environment. During their flight the bees' muscles work very intensely and their body temperature can rise, reaching as high as 40°C in the chest cavity. Solar illumination also favours this temperature rise. Therefore even when the bees fly out of their nest to empty their bowels at low air temperatures, there is no danger to their health and life.

There have been cases when honeybees spent their winter in the open air in such nests which were not protected in any way but were just attached to tree branches; and such cases were observed not only in the southern areas but even in the forests of the temperate and northern zones of this country. These bees did not even isolate their nests from the immediate effects of the environment.

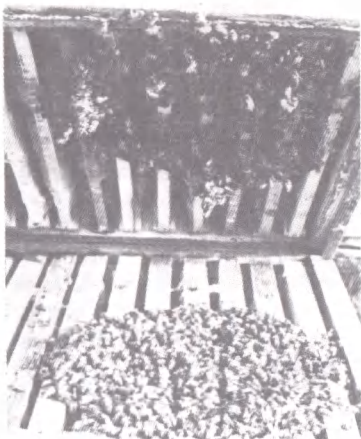
In autumn, when there are still some warm and sunny days with the air temperature in the sun above 14°C , which is equal to the temperature inside the bee cluster, the latter disintegrates and the bees come out for their cleansing flight.



This is the way they spend their winter.



A bee cluster in its natural dwelling.



A broken winter cluster which has settled in two storeys.

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Their autumn cleansing flight is short but violent. The bees seem to hurry to use every bright hour until the sun sets behind the clouds. And if the cool weather is again replaced by warm, the bees will come out flying once more, as if swimming in the bright rays of the autumn sun. The quiet and transparent sky is filled with the buzz of the bees. It tells of their joy and sorrow because they are saying good-bye to the sun and to nature which is preparing for its winter rest. The flights will go on as long as the weather permits. *The later they conduct their last flight of cleanliness, the easier they will tolerate their wintering.* In the regions of the south and in Central Asia the bees fly around even in winter. In Siberia, in the North of this country, in the Ural area and in the middle belt of Russia the bees' clusters do not disintegrate for some six or seven months.

Since the day the bees get together in their cluster, the life of the colony changes radically. Now all its activities are ruled by the instinct of self-preservation, they are aimed at only one goal which is to produce the heat vitally necessary for the bees. Nature has set one important task for the bees—they must survive and preserve the energy they will so badly need in spring. And the essence of the beekeeper's work in autumn and winter is to help the bees accomplish this task. In particular, it is very essential in autumn to provide the bees with an opportunity to leave their hives for emptying their bowels on one of the very last warm days.

Under the open sky. Nature has made the bees in such a way that they can live free in the open air all year round. The fact that beekeepers began using special premises to accommodate their bees during winter may be attributed not to the beekeepers desire to save time and effort in guarding their apiaries in winter, but rather to their underestimation of the bees' abilities to withstand low temperatures well.

With the advance of our biological knowledge on the nature of bees, there are more and more beekeepers now who support the idea of bees' wintering under the open sky. Everyone is familiar nowadays with such expressions as: "It is not the cold but hunger that bees are afraid of. When under the snow, the hives are as safe as in fur coats. It is not the frost that kills the bees but the dampness. It is not the bees who dread the cold but the beekeeper".

In their settling, wild bees usually look for such places in the forest or mountains where their home will be protected from the effect of any winds. And this is quite natural.

When packed together in their cluster, the bees are not afraid of severe frosts which can be as severe as up to 40-50 °C, but winds penetrating their home are terribly dangerous for them. With low air tem-

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peratures, the air inside the cluster may change only once within a given time period, but with a strong outside wind this change may occur several times faster. As a result, the bees will have to spend much more food and energy to replenish the heat which the wind blows off.

It was not accidental that all bee-gardens of old times were usually set up somewhere in the forest clearings or on the forest outskirts beneath heavily foliated trees and shrubs which could protect the hives well, or in the canions and crevices of the mountains which could cover the apiaries safely. The hives of the past were never arranged in gardens of estates, near buildings.

In places well protected against winds it is much easier for the bees to work on flowers and to carry their loads of nectar home, it is also much easier for them to maintain the desired temperature within their brooding nest. The bees can feel quite happy even in winter, living in hives without any outward protection. And this is the way the bees usually spend their winter.

However, it is not always possible to locate one's apiary in such a favourable environment, and particularly in one which will ensure optimal wintering conditions. The hive walls can protect the nests against the winds and atmospheric moisture very well. Nevertheless, the bees will enjoy their wintering much more if the hives are additionally wrapped with some moisture-proof and wind-proof materials. To this end, one most frequently uses tar paper, roofing felt, dark pergamyn. As a rule, the hive is wrapped with such material on three of its sides (on the lateral sides and on the back). The front wall facing the south is usually left unprotected.

The tar paper for hive wrapping is traditionally from 8 to 10 cm longer than the length of the hive's three sides. Its width is equal to the hive's height including that of the food storey or magazine up to the roof. The wrapping is fixed with a piece of string (binder twine). Such a protective "jacket" must be attached tightly to the hive, especially at its front corners, at the roof and bottom. The hive should be wrapped soon after the bees start forming their cluster but are still able to fly around.

In localities where winter winds blow from all directions, as well as in those which are particularly humid and are known for their frequent rains and wet snows, the hives are usually covered on all four sides. In front of the flight entrances one makes holes in the wrapping and secures it to the hive wall to cover the holes, so that when leaving the hive, the bees do not get under the protective jacket wherefrom they usually cannot get out and frequently perish.

Such wrappings not only protect the hives from winds, rains and

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cold, but they also encourage the bees' cleansing flight in late autumn, winter and early spring. The black colour of such jackets absorb the heat of the nest intensively. Therefore the temperature in the hive is usually considerably higher than the ambient one, thus it helps to create favourable wintering conditions for the bees. Thanks to solar radiation in winter, the cluster gets warmer and expands; the bees in it can change their position, moving upward, closer to their honey stores. Therefore, maximum solar radiation is very useful for the bees. When the hive temperature, owing to the sun light and warmth, rises to equal that of the cluster, the latter disintegrates and the bees leave the hive for their cleansing flight. At this time bees never fly out of hives which are not wrapped, and especially of those with thick walls which cannot be warmed well by the sun. It is extremely important to wrap the hives when they are still dry. If carefully and properly used, the wrapping material may last for many years.

Bees' cleansing flights are promoted by the reflected sun light penetrating into the hive through the flight entrances. If the hives face the south, their colonies will fly out more intensely in autumn. In view of this, many beekeepers arrange their hives in such a way that their flight entrances face only the south. This is usually done upon return home from the last trip with the apiary to distant nectar plants. If the apiary did not travel at all, the hives are gradually turned around so that they finally face the south.

In the natural homes of bees (tree hollows), the sun heat is accumulated by the dark bark of the trees.

The late flight of cleanliness is also necessary for those bees which are to spend their wintering indoors. Such hives are not wrapped with jackets and therefore, if one wishes, their bees can be compelled to fly out when special artificial conditions are created for them. On days when the weather permits their flights but the sunshine, penetrating through the flight entrances, fails to drive the bees out into the open air, the beekeeper opens the hives and removes the warming quilts and ceilings. Then he covers the nests with pieces of some dark cloth. If the hive has no ceiling beams but only canvas, the black cloth (or possibly strips of tar paper) is put on the hive's top. These operations will speed up the nest warming and provoke the bees to fly out. As soon as the last cleansing flight is over, the lower flight entrances in the hive must be closed with barriers against mice.

The front walls of the hives which will remain in the open air in winter are additionally secured with some sloping shields, the width and height of which is equal to the front wall: they will protect the flight entrances against snow and winds.

The falling snow will by-and-by cover the hives up. Snow is a poor

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heat conductor and therefore it will safely screen the hives from any frosts and winds. Over the course of time, a certain space will form between the hive walls and the snow covering the hive. This air shell, like a snow overcoat, will also help retain the heat in the hive and diminish the adverse effects of temperature and moisture fluctuations in the outside air.

The air temperature within this space, despite severe frosts or thaws, will be almost always at about 0°C . In this way, the hive will steadily receive not the icy-cold outside air but that which is much warmer. The bees will consume a minimum amount of food and will happily enjoy their wintering.

The bees which spent their wintering in the open air usually prove to be full of energy in spring, unlike those which passed the winter indoors and are found to be phlegmatic; the former are more resistant to diseases, they do not swarm as much as the latter, and their honey yields are usually higher. It seems likely that the cold in winter renders some healing effect on their organism and increases their vitality, making them stronger and well-tempered.

During the course of their evolution, the honeybees have adapted to low temperatures, so to speak, they have gotten used to them and now simply need them.

The bees winter indoors. There are many beekeepers who still favour the idea of keeping their bees during winter indoors, especially in regions with severe winters of little snowfall, strong winds and long duration. The walls of winter huts can undoubtedly protect the bees against winds and frosts, maintaining the indoor temperature and humidity at a level that benefits the bees' life. Underground and semi-underground winter huts are thought to be the best. They are less sensitive to low ambient air temperatures and sharp fluctuations, and as compared with ground ones, the bees living in these huts can enjoy a quieter wintering and are said to consume less food.

Bees seem to tolerate the winter season quite well when kept in the cellars of residential houses. The temperature there is usually above freezing but not high, it is constant, as a rule, while the air is dry and never oversaturated with moisture. The bees are known to behave most calmly when the indoor temperature is from 0° to 4°C . However, some beekeepers can keep their bees well at 5° to 6°C but they see that their premises are well ventilated, as well as the bees' nests (they open the lower and upper flight entrances as wide as possible, take off the warming quilt, and slightly expose the front or the back part of the nest).

Long before the bees are settled in a winter hut, it is carefully dried

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up beforehand (this is done still in summer), then equipped with a good ventilation system (inlet and outlet pipes). To get rid of any hazardous microflora inside the hut, it is disinfected with fresh slaked lime shortly before the bees are transferred to it (the walls and ceiling are whitewashed), or else it can be smoked with sulphur dioxide (50 g sulphur per one square meter of space). The hives are put on the floor, on boards or on shelves.

The shelves are arranged in such a way that they do not touch either the walls or the ceiling of the room. The floor of the dwelling should be made of earth. With this kind of arrangement, when one knocks the door and walks on the earth floor, the hives on the shelves do not shake and the bees in them are almost undisturbed.

When it becomes clear that there will be no more bright days for the bees to fly around, since the cold weather will now not get any warmer, the bees are taken indoors to remain there throughout the winter.

No matter how carefully one transfers the hives from outdoors to indoors, the bees inside the hives usually get very excited and cannot calm down soon. This, as a rule, inevitably affects negatively their tolerance to wintering. The bees raise the temperature in the hive, due to which the walls of the hives and the combs begin sweating because they were cold from the outside air. The hives immediately become damp, especially those which were previously kept in the open air under rain and are now soaking wet. If the ventilation in the room and of the hives is not proper, they will remain wet for quite a long while.

The hives are brought indoors with their flight entrances tightly closed; they are usually arranged in such a way that each one will be within easy reach of the beekeeper. To prevent the nests from any attacks by rodents, they are protected on the top: the hives are covered with roofs having special ventilation holes, or the hive tops receive magazine adapters with moving nets through which the wet air from the hive can be removed easily.

To be able to monitor the temperature and humidity of the air, a thermometer and a psychrometer are hung in one of the passage ways between the hives (best of all, in the middle of the room). An hour or two hour later, when the disturbed colonies calm down a bit, the upper and lower entrances are opened.

If the indoor temperature does not drop below zero on very frosty days, the warming quilts are removed from the nests; in hives having no upper entrances the beekeeper also exposes some part of the nest. If the nest is screened with a piece of canvas, the latter is turned back and the ceiling beams are moved apart. The solid ceilings in multiple-storey hives usually have their holes for bee escapes opened. Under

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such conditions the bees behave more quietly than in warmed-up nests, the hives do not get saturated with carbon dioxide, with moisture and dampness.

Dampness is deadly for bees. The honeybees can live peacefully in winter if the ambient air humidity fluctuates between 70-75%. With this air humidity, the water content of the uncapped honey does not rise significantly and its quality does not deteriorate.

The humidity of the atmospheric air is known to vary. When it is low (less than 60 per cent), the honey will release its moisture, get thicker and crystallize much faster. When the air humidity reaches some critical level (say, 100 percent), such water-oversaturated air will release drops of water. With this extremely high air humidity, the honey will get thinner. Both the former and the latter conditions affect the bees' wintering equally badly.

The air inside the hive is always more humid than that outside. Eating honey, the bees discharge water vapours and carbonic acid, as well as final products of the decomposition of carbohydrates. If these metabolic substances are not withdrawn from the hive, the air humidity inside the hive will gradually reach a critical level. A bee colony consuming one kilogram honey was found to discharge about the same quantity of water.

Dampness accumulating inside the hives is the worst of all calamities for wintering bees. The uncapped honey can absorb the moisture from the air in the hive like a real sponge. Its water content can thus increase by two or three times. And because this honey always receives the warmth from the bee cluster, the yeast fungi, which it usually contains, begin multiplying. The honey starts fermenting. The beebread also sours.

If the bees receive spoiled food, their metabolism gets disturbed and their digestive system begins malfunctioning. Food containing excessive water is the major cause of dysentery.

When fed on top-quality honey and beebread, the remains of the undigested food become dehydrated and thicken up. Now, with their food overly moist, the rectum of bees cannot normally absorb the water and gets overfilled with liquid excrements which the bees are no longer able to retain.

The malfunctioning of their intestines makes the bees weaker and their organism resistances are lowered. These factors create conditions favourable for the spores of nosema to multiply rapidly. As a result, the bees begin to drop in large number. Excessive moisture in the nests is also very conducive to the reproduction of the varroa mite.

In addition to all these adverse effects of high humidity in the hive,

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it causes the combs to mould. As compared with a hive where the air is dry, in that with damp air the bees' cluster loses its warmth much more intensely, because the damp air is of higher heat capacity and heat conductivity. Damp nests usually persistently retain the cold.

The worse the ventilation and the lower the moisture capacity (the ability to absorb moisture) of the ambient air, the greater the danger of hive dampness.

There are different points of view on hive ventilation. Some beekeepers favour the idea of strong ventilation by providing for additional air exchange through the ceiling, even when both the upper and lower flight entrances are open. Other beekeepers are afraid of draughts and prefer to keep only one of the upper entrances open in winter.

It has been noticed that bee clusters in poorly ventilated hives become loose because the bees try to ventilate their nest as much as possible; they become restless and wear out physically, while still wintering, long before they should. Such colonies are found to lag behind in their growth.

In a well ventilated hive, where the metabolic products do not accumulate but are removed as they are released by the bees, the nests are usually clean and dry, the colonies are full of energy and grow well in spring.

As seen from recent practice, when the bees enjoy their wintering in the hive with its lower flight entrances wide open, they feel much better than if the flight entrances are opened to only 2 or 3 cm, as some beekeepers used to prefer. This observation is equally valid for the bees wintering both indoors and outdoors. The small lower entrance is, as a rule, almost always packed in winter with dead bees, and frequently with ice. As a result, the inflow of fresh air to the hive is virtually cut off, though the bees always need it badly, and during wintering their demands for air do not diminish. According to the great Russian apiculturist, Academician A. M. Butlerov, a wintering bee colony needs about 8 cubic feet of air (one cubic foot is equal to 28.32 liters) per day. The bees need this huge amount of oxygen to have their food well processed and to dilute the carbonic acid they release. Such great quantities of air may enter the hive only when it is well ventilated. As L. Langstroth asserted, when it is cold the bees must have fresh air easily accessible to them. As he calculated, the bees need as much air in winter as they do in summer.

When the bees spend their wintering in the open air or in some cold place, the temperature in the hive is practically almost the same as outdoors, and the humidity is usually higher. When the hive ventilation is good, the per cent of air humidity in the hive does not rise even

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when it receives the superhumid atmospheric air during prolonged thaws. The proper and timely removal of damp air from the hive cannot be guaranteed by opening both the upper and lower entrances along. To promote this process, the hive is additionally ventilated through its ceiling which is carefully examined for the purpose still in autumn. In multiple-storey hives in particular, the ceiling with its hole for the bee escape is covered with a loose moss pillow or a porous porolon screen through which the hive will receive additional ventilation steadily.

As L. Langstroth wrote, to guarantee a safe wintering for one's bees, one has to observe strictly a very important rule, i. e. he must put on top of the frames something capable of absorbing the moisture resulting from the bees' sweating. The ceiling ventilation is more reliable than that through the upper entrance which is usually clogged with hoarfrost during severe frosts which retards the air exchange in the hive.

Ceiling ventilation in hives during winter is widely practiced by Finnish beekeepers. So far, Finland is the northernmost country where honeybees are kept. Finnish beekeepers prefer multiple-storey hives with thin walls. In winter they leave them in the open air with their upper and lower entrances wide open and free ventilation through the top of the nests. With this natural kind of ventilation, or ascending, as L. Langstroth called it, there is never any dampness in the hive and the bee cluster never suffers from draughts. The air in the hive circulates slowly, so that the bees do not even respond to this air movement at all. Vertical multiple-storey hives are highly suitable for this type of ventilation. The air inside such hives is always drier than in horizontal ones.

The inflow of cold air to the hive is the only way to remove its moisture. Cold air is drier than warm air. Entering the hive from the outside, it does not bring in any moisture, but, on the contrary, getting warmer, it absorbs the water that already exists in the hive. The air current, which is always strong in the hive when two of its entrances and the ventilation hole in the ceiling function normally, will by-and-by carry all the excessive moisture out of the hive, preventing it from settling on the hive bottom, and thus normalizing the environment in which the bees live. It may sound strange, but in a well-ventilated hive the bees feel warmer than in the one where the air is wet and stagnant.

If the ventilation in the hive does not help to remove the over-moistured air from the hive properly and timely, the hive moisture, due to the gradient to temperatures in the indoor and outdoor air, will precipitate on the bee-free combs, the walls of the lower storey and the bot-

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tom. The dampness accumulating here makes the combs and the bee-bread mouldy by spring and they become virtually useless in the nest; thus the honey gets sour.

It is always dry in the hive and the bees feel better when during their wintering the space under the frames is larger and there is a sort of air pillow.

This is the way almost every natural dwelling of wild bees is arranged, since beneath their winter cluster there are always large places either housing combs or containing no combs. This is the area of their cavity which serves as a sort of reservoir for carbon dioxide saturated with water vapours.

Bees' wintering on an air pillow has been widely practiced in Czechoslovakia. According to B. Tomaček, colonies which wintered in the lower storey free of bees and combs, proved to have at least 40 percent more spring brood, on the average, and in summer, before the main honey flow, 30 percent more brood than colonies which had no lower storey in their hive during wintering.

Such an air pillow is especially vital for colonies wintering in one storey. To create this pillow still in the mid-autumn the beekeeper puts an empty storey or a magazine adapter beneath the nest. Enjoying a large vacant space under the nest, some part of the bee cluster is now formed not on the combs but under them, and owing to this, the bees in any hive street can now communicate with the queen.

The air pillow also eliminates the danger that the bees will get excited or perish from hunger in that hive street where the food might run out before the end of the winter.

The upper warming quilt (made of moss, porolon, sedge) has two functions: it protects the nest from its top against cooling, and partially absorbs and releases back to the atmosphere the moisture which did not leave the hive through the upper flight entrance.

When nests are overheated in winter, their ventilation gets disturbed and the hives inevitably become damp.

The temperature and humidity inside the winter hut where the bees are kept, are usually regulated by increasing or decreasing the room ventilation. The cold frosty air with its very low absolute humidity will eagerly absorb water vapours, considerably diminishing the relative air humidity in the winter hut.

When the indoor ventilation is insufficient, it cannot normalize the inside air and therefore one has to open the hatches, leave the door wide open at night, and even take to additional measures, such as humidifying excessively dry air by hanging some wet clean rags in the hive or by spraying water on the floor. The presence of excessive moisture is determined by means of a psychrometer or by salt bags in-

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stalled on the shelves. All excess water is removed with the help of the so-called dryers (quicklime, activated charcoal, etc.).

It is very important to improve the hive ventilation closer to spring when brood appears and the bees need more oxygen. Stuffy premises are simply deadly for bees.

If the bees are dormant, their wintering is much better. Nothing should disturb the bees' peaceful winter dormancy which they usually enjoy quietly under natural conditions. When the bees are in their long and deep dormancy, their wintering is usually normal. Any attempt to disturb this dormancy, even for a short while, causes the colony to respond violently.

The metabolic processes in the bees violate their normal rhythm and get intensified, the bees' body temperature rises, bringing about the rise in the temperature around the bees; the respiratory organs function at a higher rate, likewise the digestive system and the centres controlling the heart activity of the bees.

Any disturbance in the normal physiological processes occurring in the wintering bees complicates their wintering.

In man-made shelters (winter huts), wintering bees are often disturbed by mice. Radical measures are usually taken against rodents: their burrows and the place near them receive special fodder treated with rat poison (α -naphthylthiourea, Warfarin) or infected with mouse typhus. Poisoned fodder is scattered inside the hut (along the walls and in the corners), mice-traps are also installed there.

Good results against mice can be obtained by using poisoned casein glue. Its pieces are put near the hives or close to the places penetrated by the rodents who enjoy it like a nice treat, but it acts as a killing poison. Very effective against rodents are such things as cement and gypsum added to flour or combined fodder. They harden up once inside the rodents' stomachs, and the animals die.

Mice cannot penetrate the hives near which there are stalks of thistle, hound's-tongue or spruce boughs.

Bees get easily disturbed in their winter dormancy by people who are not quite careful when paying visits to their winter huts. Loud conversations during such visits, bright lights, cigarette smoke inside the hut, an accidental knock on the hive or an occasional knock intended to check the state of the colony, any of these things will excite the bees and they will not calm down for quite a long time.

A colony's dormancy can be interrupted by the death of the queen, by excessive dryness or excessive humidity of the hive's air, by high temperature, by extreme amounts of carbon dioxide in the nests. All these things complicate the bees' life and compel them to use more

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energy, more food, and finally worsen the results of the bees' wintering.

In order to help the bees enjoy their winter dormancy as much as possible, their winter nests are visited very rarely (once or twice during the first part of the winter and only when absolutely necessary during the remaining winter months). While visiting the winter hut, one usually lights it with an electric pocket torch of red glass (red light does not irritate the bees); if one desires to hear the bees, one must attach a thin rubber pipe to the flight entrance.

Upon entering the winter hut, the beekeeper listens to the sound coming from the nest. If it is smooth and quiet, of low tone, it means the bees' life is quite normal. If the sound is not homogeneous but there is a sort of higher-pitched and alarmed quality coming from a part of the hut, the beekeeper must find the colony sending its distress signal and establish the reason for the bees' excitement so as to eliminate it, even though he will have to disturb the other colonies in the process.

With the approaching spring and the appearance of the brood in the nest, the bees' life becomes more complicated. The amount of undigested substances in their organism increases daily since they consume ever increasing quantities of food, especially proteins. Any disturbance of the normal conditions of their wintering, no matter how insignificant it may be, if it involves additional consumption of food and additional losses of energy, may untimely overload the intestinal system of the bees and thus weaken the colonies. That is why it is tremendously important to provide for the absolutely undisturbed dormancy of wintering bees. To prevent the bees from consuming any extra food to maintain the heat necessary for brood rearing, the part of the nest open for ventilation is now covered with a warming quilt.

Colonies wintering outdoors do not need any special care or concern. It is only towards the end of winter, when the sun begins shining warmly and the bees may have their first opportunity to fly around, that the shields are taken off the front walls of the hives and the flight entrances are cleared of the dead bees and barriers.

So, *the honeybees have historically adapted themselves to long and severe winters which they can now tolerate easily.* But if the natural conditions which they are used to are violated, the consequences may be very serious for the bees and they may even perish. In this way, the final outcome of wintering greatly depends on the skill of the beekeeper. G. P. Kandratiev was quite right when he emphasized that "a safe wintering is the foundation of all beekeeping. Until you are absolutely sure that all your colonies left for wintering will emerge alive, strong, hale and hearty in spring, all your expenditures, all of

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your tricks, likewise all of your hopes for the future will remain futile in the full sense of this word.”*

* * *

Bees are one of the most amazing creatures of nature.

A colony of honeybees though composed of tens of thousand of individuals, is an integral organism, and each of its individuals is a unique organ having a definite function.

The queen never ceases to lay eggs if she is provided with proper conditions, good food, the necessary temperature in the nest and vacant cells in the combs. The working bees manifest mainly to the two most important jobs—they rear the brood and gather food.

The life of a bee colony depends on the activity of each and every one of its individual, and its harmony is determined by the coordination of their joint efforts. Each member of the colony performs such jobs appropriate for its age.

All individuals in the colony are closely interrelated with one another. The cells necessary for the queen's egg-laying are prepared by the bees. The bees also feed the queen. In this way, the rate of egg-laying largely depends on the will of the bees.

The links between the bees themselves are innumerable. One can observe their constant food contacts.

This rather distinct division of labour in bee colonies seems to compose a unique production line, a kind of continuous “technological” process. The end product (honey and/or a young bee) results from the efforts of the entire colony.

The life of a bee colony, which is an intricately made and a biologically perfect organism, is closely related to the environment of which it very much depends.

When nature wakes up, the bees come out of their dormancy, the queen starts her egg-laying. The warm spring and the first flowers increase the flying activity of the bees and stimulate the colony's growth.

Cold weather, likewise the absence of a honey flow, diminishes this activity and retards the growth of colonies. When the honey flow is poor, the instinct of reproduction (swarming) intensifies in the bees, whereas a strong honey harvest will dull the instinct of reproduction but that of food accumulation will greatly increase.

It is nature, and in the first place the weather conditions, as well as

* *Vestnik inostrannoi literatury pchelovodstva* (Herald of foreign literature on apiculture), No. 1, p. 9 (1899) (in Russian).

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the state of the plant kingdom, that determine the behaviour of honeybees, enhancing this or that of their instincts and making it dominant for a certain period of time.

One of the most important elements of practical beekeeping is to learn how to determine timely the boundaries of each physiological state of the colony, so as to be able to sharpen some of the bees' instincts which determine this particular state and are beneficial for bees and for man (the colony's growth, honey collection), and to prevent the augmentation of others that may reduce the bees' productivity, such as swarming, for example. A. M. Butlerov wrote that “the well-known external influences are all in our hands, and making use of this, we can direct the activities of our bees in such a way that the results match our goals as much as possible; to achieve this, we must know the theory of apiculture and understand as clearly as we can *the dependence of each member of a bee colony on all the others, and the dependence of all colony members on the external conditions* (emphasis—A. M. Butlerov). He who possesses this knowledge and understanding, and who can use it in practice, may regard himself as a quite practical beekeeper”.

How to Make Your Own Hive



he modern hive, the home of bees, has resulted from man's century-old thoughts and searches.

Under natural conditions, honeybees are known to live in tree hollows. Therefore it was a tree hollow that became the prototype for the hive. At first it was a piece of a hollow part of a tree which was cleaned from its mold and then enlarged and covered with bark. Such hives used to be attached to trees, then man began to hang them somewhere in forest clearings or in his garden near the house.

The next stage in the evolution of the beehive was the locating of log hives in woody places, or hives wattled of straw or sedge and used in the steppe regions, while those made of clay were used in mountainous areas. These hives permitted people to watch, to some extent, the life of honeybees in their nests. It may be suggested that at that time the unique technology of beekeeping began to develop.

In his aspiration to comprehend the bees' life better and to get to know their nature, man started to build hives that could be disassembled. Now he could already divide the hive into separate parts, remove any excess honey, increase or decrease the volume of the nests, if he found it necessary.

The further biography of the man-made home for honeybees is connected with the invention and improvement of the frame hive. This design permits the division of the nest into separate and smaller sections—combs and thus the life and activity of the bee colony can be controlled.

History knows of thousands of different shapes and forms of frame hives. It is not accidental that people say: there are as many types of hives as there are beekeepers.

Modern apiculture has accepted several types of hives. They are divided according to their design into vertical ones, in which the nests are similar to those inhabited by bees in nature, i. e. they are taller

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than broad; and horizontal ones, in which the nests are wider than tall.

Nowadays, vertical, multiple-storey or multiple-magazine hives are most popular.

The Multiple-storey Hive

The multiple-storey hive was invented by the outstanding American apiculturists L. Langstroth and A. Root over 120 years ago. Since that time its design has undergone many changes and improvements until it attained its present classical simple shape.

It consists of several nest storeys, magazine adapters for honey, a bottom, a roof, a dead ceiling, an inset for the flight entrance, a dividing grid and a stand.

The storey is a box with the following internal dimensions (in mm): 375 mm wide, 450 mm long, 240 mm high. It holds 10 frames which are 435×230 mm in size (the frame of the Langstroth-Root model is 441×232 mm). At first the hives used to have storeys for 8, 10 and 12 frames. Later on, the hives of the two former types became more popular.

With the standard width of lateral frame planks (37 mm), a 10-frame hive had to be made 370 mm wide and not 375 mm, as it is practiced in this country. However, because of a propolis layer settling on the frames, it is rather difficult to install the entire set in the storey or to withdraw a frame from it. Furthermore, due to the temperature and humidity fluctuations of the air, which occur in the hive during different periods of the season, the frames swell slightly.

Nevertheless, as seen in practice, such an allowance is not sufficient. Many apiculturists began expanding their storeys to 380 mm in width. Respectively, all other parts of the hive must be widened, too. It should be mentioned, by the way, that the company bearing the name of Root is manufacturing its hives with an allowance of 10 mm.

This rather small size of the hive storey permits the expansion of the nest volume not by means of separate frames but by using a whole storey at once.

The Soviet industry manufactures hives having walls of 35 mm thick; in Canada, the USA, Finland, Rumania the hive walls are 20 to 22 mm thick. The beekeepers in these countries believe that such thin-walled hives are in no way worse than those with thick walls. And storeys of lighter weight are, naturally, much easier to work with.

The storey walls are linked by a straight pin and additionally fastened with nails. There are holes drilled to prevent the pins from splitting.

How to Make Your Own Hive

The roof of the hive.

The hive ceiling.

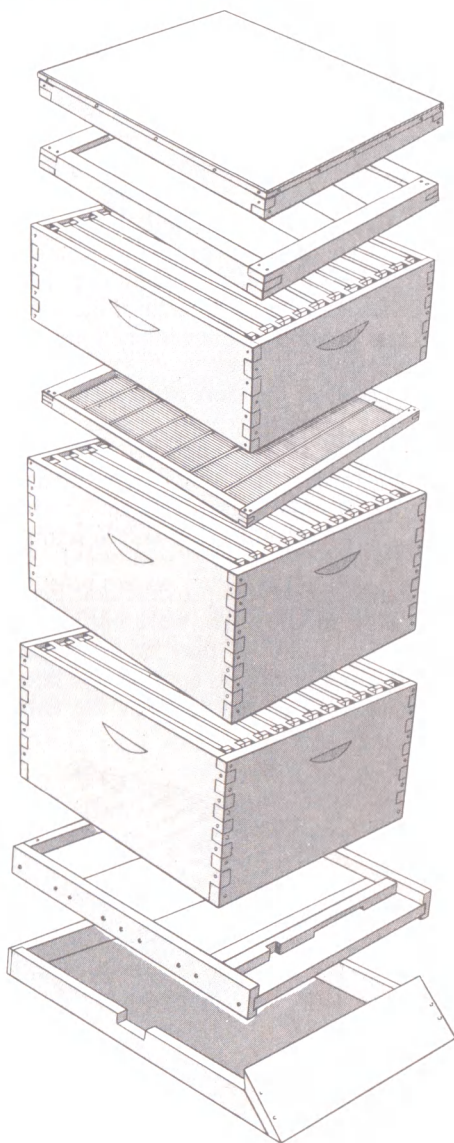
The super.

The dividing grid.

The hive storey.

*The bottom board
of the hive.*

The hive stand.



A multiple-storey hive.

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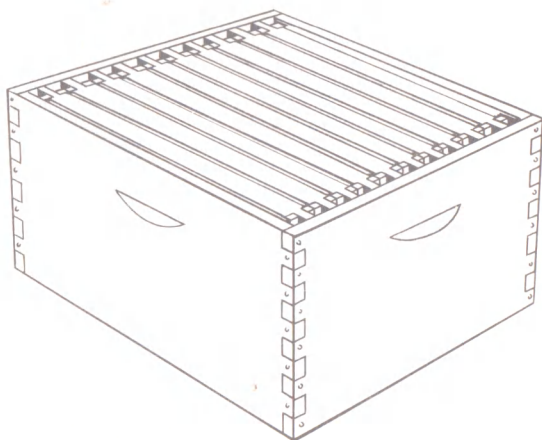
Storey planks are cut from whole boards with a processing allowance of 2.5 to 3 mm thick in all directions, and with a face allowance of 10 mm. Taking into account all allowances, the boards for the front and back walls are cut to be 465 mm long and 245 mm wide, those for the lateral walls are 540 and 245 mm respectively. Only boards cut of soft tree species can be used for hive making; such trees must be nonpitchy, well dried and seasoned for at least one year.

In the front and back walls (from the inward side near the upper edges) there are grooves for the frame arms which are 11 mm wide and 17 mm deep. With such a depth of the grooves, the frames go 7 mm beneath the upper edge of the storey. This space above the rods makes it possible to put each new storey on the hive without any risk of smashing the bees.

The walls of the storey (on their outward side) are designed with openings for the beekeeper's hands. They are usually cut in the middle of each wall, some 70 mm below the upper edge. Such openings are very convenient for lifting a storey up and carrying it to another place.

A round flight entrance 25 mm in diameter is drilled in the front wall under the cavity. It is used in summer and winter to ventilate the hive.

Finnish beekeepers provide their hives with upper flight entrances not in the middle of the walls but on the very top (in the interstorey space); in addition, they do not make them round but slit-like, because they justifiably consider the latter to be more handy for bees' work (having passed through the entrance, the bees immediately



The hive storey.

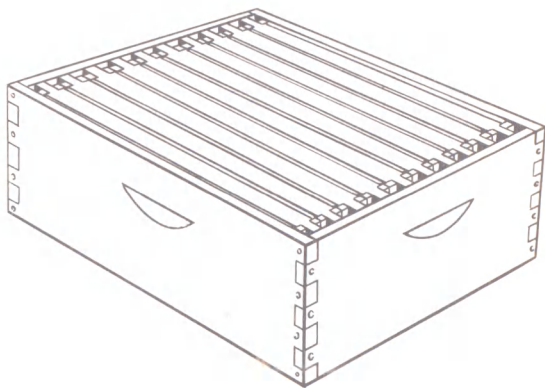
How to Make Your Own Hive

reach the interstorey space and go directly to the upper rods of the frames) and conducive to good air exchange in the hive.

The storeys are connected by butt-joints without any grooves. Some beekeepers claim that hives with their parts butt-joined, without any grooves between them, are usually colder and their storeys shift during travelling. But this opinion is incorrect. If a hive is made precisely of well-seasoned wood, it will have no slits. When travelling with his apiary to a new place, the beekeeper usually has to fasten the parts of his hives (be they with grooves or without them). The clamps, particularly those which have a pulling effect, join the parts of a grooveless hive so firmly that nothing can shift even when the hives are carried horizontally.

Butt-joined storeys have some other undeniable advantages over grooved storeys. Grooveless storeys are easier to make and much more handy to use.

When working with multiple-storey hives, one is known to perform several individual operations with each storey separately. By changing the storeys in their order or by installing a new one across the others, the beekeeper disturbs the bees which start running down the hive walls and enter the grooves. It is rather frequent that the queen also goes there. When storey is being put on the hive, the bees inside the grooves may get smashed. In shifting grooveless storeys for increasing the ventilation in the hive during the main honey flows in summer, the interstorey space is never disturbed. In grooved storeys, the interstorey space is usually doubled. The bees build it up with their combs,



The super (the honey chamber).

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and thus the storey cannot be brought back to its original place until all the new combs are removed.

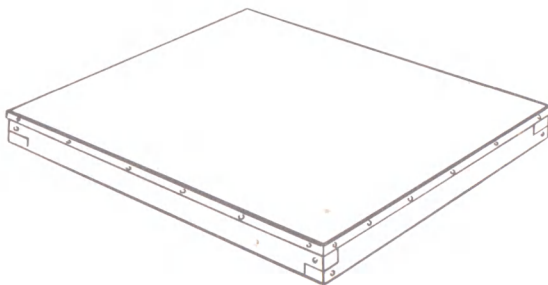
Such grooves complicate the construction of the bottom, of the dividing grid and of the ceiling.

The super (magazine) is made in the same way as the storey. According to the standard, the size of the frame is 435×145 mm (American beekeepers use magazine frames which are 136 mm high). Magazines have no flight entrances. They are installed on the hives for the period of main honey flows. To obtain honey combs with more honey and preclude any possibility of the queens working in the magazines, the latter receive eight frames.

The roof is flat, and is put on the hive like a cap. The roof is composed of the casing, panel and roofing. The casing is joined by a pin of 20 mm deal. It is 80 mm high and in all directions it is 4 to 5 mm wider and longer than the exterior dimension of the storey. This clearance allows the beekeeper to put the roof on the hive and take it off without any difficulties. Thanks to this clearance, the hive ventilation improves greatly during winter.

To improve the hive ventilation, one sometimes makes 10-mm slits in the front and back walls of the roof along its entire width. To prevent these slits from being closed by the warming quilt, the lateral walls of the roof from their inward side, right up to the panel, are nailed with rods 20 mm high, which the roof rests on. Thus the warming quilt never gets wet.

The roof panel is assembled of small planks 20 mm thick and then is covered with tin. When the roofing is so thick, it can protect the bee colony well from solar overheating.



The roof of the hive.

How to Make Your Own Hive

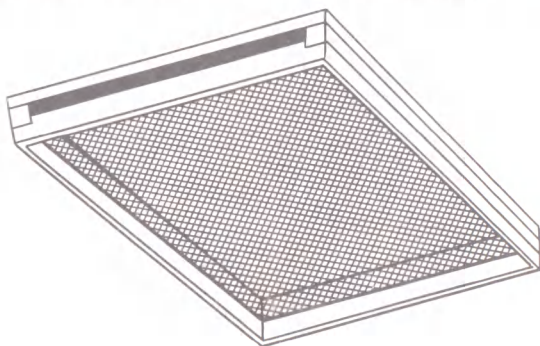
Warming quilts are not fixed in the roof.

There are cases when the hive roof may have a moving net in it providing for reliable ventilation of the hive during travel or when the beekeeper occasionally isolates his bees for a short time (a day or two) while treating the plants with toxic chemicals. On its top the casing is covered with a metal net with 2×2 mm cells and having rods of 8×20 mm extended along the whole length of the lateral walls. A panel is assembled of wood-fiber board or of grooved small planks; the panel is nailed to the casing together with the rods.

The panel is covered with tin. To prevent rain water from running through the ventilation slits into the hive, the lower edges are sloped at a 45° angle. Before the roofs are put on the hives, their ceilings are removed.

When their hives are transported, the bees cluster above the frames of the top storey. To create this space, rods are nailed some 30 mm off the roof's edges on which the roof can sturdily rest during motion. This space above the frames is 50 mm high.

The bottom is removable, bilateral, made of three rods of the following size: two lateral ones $570 \times 65 \times 35$ mm, and the back one $445 \times 65 \times 35$ mm. Each rod has a longitudinal groove 20 mm from the upper edge which is 10 mm deep and 35 mm wide. The rods are pinned together and fastened by wooden nails. The floor made of grooved boards is inserted into the grooves of the rods. That side of the bottom which forms a flight entrance opening 20 mm high is usually used in winter and summer, the other side (10 mm high) is used in autumn and spring. But with this method one has to turn the bottoms several times. This operation is especially difficult to perform in summer, before the onset of the main honey flow, when the hives



The roof with wired ventilation.

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are large and the storeys are heavy. As seen from experience, such labour-consuming jobs can be avoided if the beekeeper uses only that side of the bottom which has a larger entrance opening throughout the year.

When the space under the frame is large, it greatly improves the air exchange in the hive and benefits the bees' wintering. This large space will not harm strong bees in spring or autumn either, if the outside cold air is properly kept out by a special entrance insert.

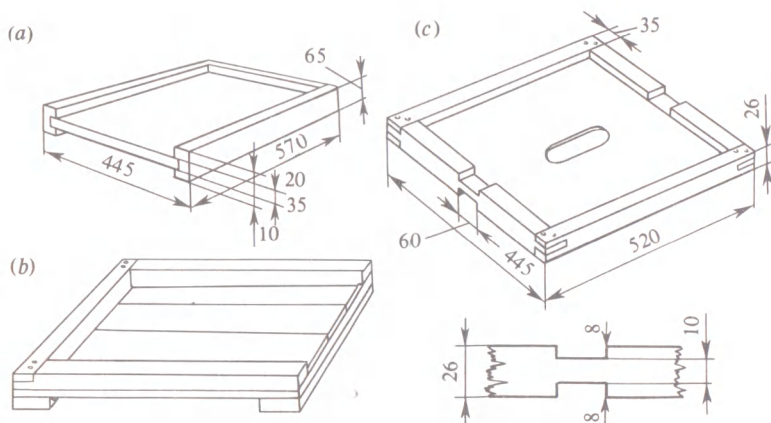
In summer, when the main honey flows are in full swing, the bees work better in hives whose subframe space is large rather than small.

A good supply of air beneath the nest and a wide open flight entrance improve the hive ventilation and normalize the temperature and humidity of the air in the bees' home.

It is usually nuclei and weakened colonies that are put on bottoms with small subframe space.

The bottom protrudes some 50 mm beyond the front wall of the hive, thus making a bee board.

If the bottom is unilateral and nonreversible, its design is much simpler. Some rods are nailed on the floor, which is 25 to 30 mm thick, at the edges of the back and lateral walls. The rods are 20 mm high and their width is equal to that of the storey walls. The rods support the hive storeys. Similar rods are nailed from below in front and at the rear of the floor to strengthen the support.



*The bottom board of the hive:
(a) reversible; (b) non-reversible; (c) dividing.*

How to Make Your Own Hive

To make the flight board more convenient for the bees, plank is nailed to the front of the floor at its butt end.

To prevent rain water from entering the hives with horizontal floors, such hives are usually inclined slightly forward. Dividing bottoms are employed in two-queen beekeeping.

The ceiling is solid, 520×445 mm in size. It consists of a panel (shield) and a rim. The rim is made of strips 15 mm thick and 35 mm wide; the panel is made of matched or grooved small plates 10 mm thick. The panel is 470 mm long and 395 mm wide. There is an opening in its middle for bee escape; it is 40×100 mm in size. A feeder can be installed in this hole and in winter it is used for nest ventilation.

On one side of each rim strip there is a rabbet 10×10 mm in size. The strips having their rabbets inward are used to connect the frame (it is better if it is pinned). This frame accommodates the plates of the panel, one by one, which are nailed to it.

Such a ceiling is smooth on one side and the rim protrudes by 5 mm on the other side. The ceiling is put on the hive storey with its smooth side down. Some space 7 mm high is formed beneath the ceiling, permitting the bees to move easily and freely between the ceiling and the frames.

In addition to its direct purpose, the ceiling may also be used as a horizontal partition when there are two colonies in one hive. The sub-frame space for the secondary colony will be 8 mm.

In this case, the hole made in the ceiling for bee escape is covered with a metal thick grid, or closed with a wooden plug. A flight entrance 50 to 60 mm wide is cut into the bottom rim from its front or back side. As a rule, the round upper entrance is kept closed.

The dividing grid is used for brief isolation of the queen in one of the storeys; in the two-queen method and in some antismearing techniques it isolates the brooding nest from that with honey.

A wire grid is regarded to be the best. Honey-loaded bees find it easier to pass through wire grids. Grids can also be made of plastic.

The dimensions of any grid correspond to the inside size of the hive storey. The grid is installed right onto the rods of the frames.

The flight entrance plug (insert) is a block 20×20 mm in size, its length is slightly smaller than the width of the lower entrance. It has two cuts along its sides: a 50×8 mm cut on one side and a 150×10 mm cut on the other, adjacent side. When the weather is cold, the bees fly through the smaller cut; when the weather becomes

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consistently warm, the insert is put in the wide entrance and they fly through the larger cut.

The insert is withdrawn completely during main honey flows.

The frame is self-dividing, 435×230 mm in size. The lateral planks of the upper third of the frame are extended to 37 mm which makes them unmovable and maintains a constant distance between them.

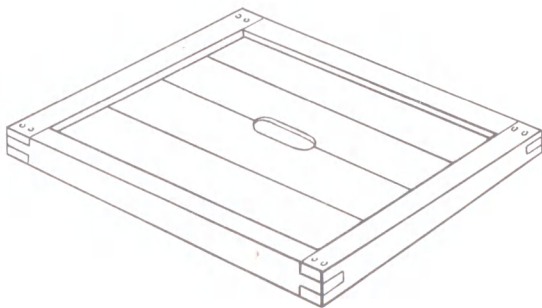
The lower planks of the frame are equal to the lateral ones in their width and thickness. If one nails down little rods instead of the planks, and the rods are 10×10 mm in size, the bees will construct cells there, usually those of drones, and will build up the space between the magazines. All this will complicate the beekeeper's work in the hive.

The hive stand is a box of 30-mm deals, it fits the outer dimensions of the bottom. Its back corners are connected by a pin. The lateral sides of the frame are inclined at 45° . A plate 140 mm wide and 445 mm long is nailed to them, which, together with the protruding part of the bottom, makes up the flight board.

The upper part of each lateral side of the stand has one cut 25×90 mm in size. The cuts permit the hive to be lifted by its bottom by hand or the insertion of a clamp there when preparing the hive for transportation. Also, the cuts promote the air exchange under the stand. No moisture is ever retained there and therefore the bottom is always dry from below.

The upper part of the flight board is planed off at an angle along its entire length. When the hive is installed onto the stand, the floor will be at the same level as the flight board and will fix it securely.

When the bottom is rotated with its two small protrusions up, the



The hive ceiling.

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upper edge of the flight board will prove to be 10 mm below the floor level. But this will not in any way affect the flying activity of the bees.

To prolong the service time of the hive stand, it is treated with bitumen dissolved in gasoline. Gasoline vapours will soon evaporate and bitumen will penetrate deeply enough into the wood pores, making the stand nonsusceptible to moisture.

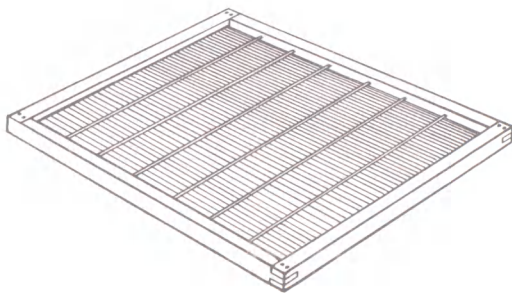
The Long Hive

Long hives can be designed to have 16, 20, and 24 frames of 435×300 mm in size. The bee nests in such hives are expanded not vertically, as is the case in multiple-storey hives, but horizontally. This explains its name. A 16-frame hive is meant for one colony, those of 20 or 24 frames are usually for two-queen colonies.

The long hive consists of a storey, a magazine, a bottom, two diaphragms, a ceiling and a roof; 16-frame hives usually have two magazines.

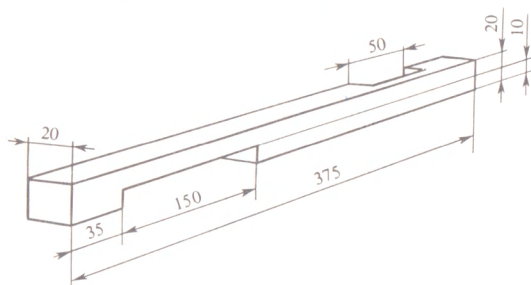
A long hive is an oblong box with its bottom permanently nailed. Its inward dimensions are as follows: 390 mm high, 450 mm wide; the length depends on the number of frames. To find the length of a long hive, the number of its frames is multiplied by the width of the lateral plank of the frame together with the constant divider of 37 mm. Added to the obtained figure is the width of the diaphragm (15 mm) and the width of the streets between the diaphragm and the combs (6 mm).

Here is an example of how to determine the length of a 20-frame long hive: $20 \text{ frames} \times 37 = 740$ mm. A long hive for 20 frames has two diaphragms: $2 \times 15 = 30$ mm. The width of the streets on this or that side of the diaphragm dividing the hive into two parts, and of one street near the second, last diaphragm, will be: $3 \times 6 = 18$ mm. So,

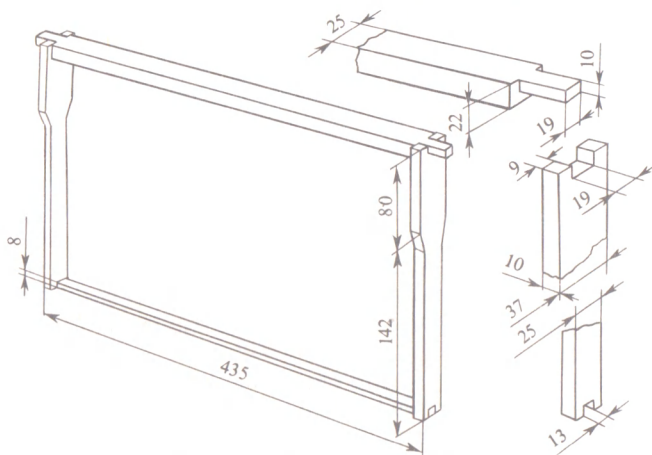


The dividing grid

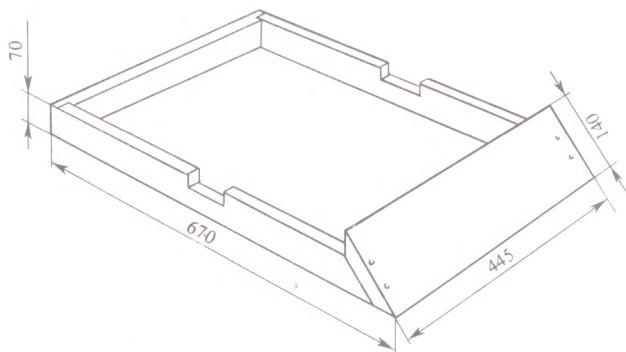
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The insert for limiting the flight entrance.



The frame of a multiple-storey hive.



The hive stand.

How to Make Your Own Hive



A skep.



A multiple-frame observation hive.

the inward length of the hive storey in a 20-frame hive will be: $740 + 30 + 18 = 788$ mm, or roughly 790 mm.

The height of the walls is composed by the height of the frame (300 mm), the subframe space (20 mm) and the space above the frame (10 mm), the thickness of the ceiling (10 mm) and the space above the ceiling (50 mm) where the warming quilt is placed, and a magazine—during the period of honey harvest. Thus, the height of the walls will be equal to $300 + 20 + 10 + 10 + 50 = 390$ mm.

The width of the long hive is found by adding the value of the frame width (435 mm) and that of the space between the lateral planks of the frames and the front and back walls of the hive (each being $7.5 \text{ mm} \times 2 = 15 \text{ mm}$): $435 + 15 = 450$ mm.

For all walls, except the front one, the bottom has a rabbet 35 mm high and 20 mm deep. In addition, the front and back walls have such rabbets on the butt ends to attach the lateral walls. On their top there are grooves for frames of 20 mm deep and 12 mm wide, and those for the ceiling which are 60 mm deep and 12 mm wide.

A 20-frame hive has two flight entrances. The lower one is cut in the middle of the hive and its size is 300×10 mm; the other, above the first one, is round and is 25 mm in diameter, it is some 240 mm from the floor.

To keep two colonies in a 20-frame or a 24-frame long hive, they are usually provided with two lower and upper entrances which are shifted from the middle of the hive towards its lateral sides. The lower entrances are reduced to 150-250 mm in width.

Long hives with two colonies usually receive magazine adapters after the colonies are joined together. The adapters are made of 25-mm deals and their inner dimensions are $450 \times 774 \times 155$ mm. The front and back walls, as well as the storey of the hive, have

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grooves for frames. This magazine is called the internal one. It is installed in the ceiling grooves.

The ceiling in the long hive can be disassembled. It is made of plates which can accommodate three or four frames, it is 10 mm thick and 498 mm long.

The roof is flat; its box is secured by a pin of deals 20 mm thick and 120 mm wide. The front and back parts of the roof are 904 mm long, the lateral ones are 564 mm long.

The inner parameter of the roof's box will be 864×524 mm, or 4 mm larger than the outward size of the hive storey. This clearance permits the roof to be placed onto the hive like a cap.

The panel of the roof is constructed of plates of the same thickness, then it is covered with tin or tar paper. The roof corners have trestles which are 10 mm higher than the box walls. These trestles (rods) support the roof.

When the hive is transported together with the bees, special ventilation cuts are made in the lateral walls of the roof's box under the outside edge upward at a 45° incline. These cuts will prevent the penetration of direct solar rays and atmospheric moisture. It is also possible to mount a screen similar to that in the moving roof of a multiple-storey hive.

A 12-Frame Hive with Magazines

The design principle of a 12-frame hive with honey magazines, as well as the material used in its construction, are the same as those for long hives. This hive consists of a storey, a bottom, two or three magazines, a ceiling and a roof.

The storey has the following inner dimensions: $450 \times 450 \times 330$ mm. The inward side of the front and back walls has grooves for frames, the outward side of all walls has grooves for magazines.

Some beekeepers use a piece of canvas instead of the wooden ceiling in 12-frame hives. The lower flight entrance is cut along the entire width of the front wall of the hive. The upper entrance is round and conventional.

Magazine adapters are made of boards which are of the same width and dimensions as the storey, but they should be 155 mm high.

At present, magazines of such hives usually receive not 12 frames but only 10. Industry is now manufacturing such frames with expanded lateral planks (up to 44.5 mm). The upper rods and the lower planks are the same as before.

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The enlarged lateral planks provide for more spacious honey combs and also make their transportation safer. Such combs usually sit in the magazines very firmly.

The roof is made flat and flush with the magazine walls. It rests on the outward grooves of the magazine. The roof is 80 mm high.

In the USA and other countries, such hives are designed for 10 or 11 frames, the bottom is usually removable and all parts are joined without grooves. Its only difference from a multiple-storey hive is in the volume of the nest section.

When constructing beehives, one should strictly follow the exact dimensions of their parts. The latter are checked and fastened by means of patterns. To make the hive parts interchangeable (such parts as hive storeys, magazines, bottoms, etc.), they are assembled on a strictly horizontal surface (its level precisely aligned). Such surfaces are especially vital when making grooveless hives.

The standardization of all hive parts is mandatory.

To the Reader

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THE WORLD OF AMPHIBIANS

B. Sergeev, D. Sc. (Biol.)

The book is a fascinating story about amphibians, the oldest inhabitants on the Earth. As a result of evolution, amphibians gave life to a great variety of the animal world. Amphibians are very voracious and as predators they present a great danger to agriculture. Whatever the problems with amphibians, as biological phenomena they play a great role in the life of our planet.

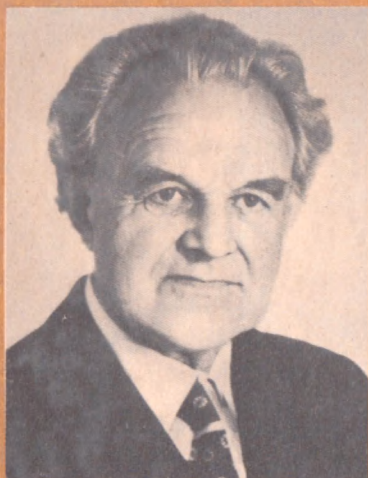
The reader will be acquainted with the most widespread amphibians, their evolution, and peculiar morphology of their organism.

POPULATION BIOLOGY

A. Yablokov, Mem. USSR Acad. Sc.

The past few decades have witnessed the appearance of a number of new trends in biology connected with the study of natural populations: population morphology and physiology, population genetics, population embriology and etiology. Together with classical population genetics and ecology, the above-mentioned aspects comprise the content of population biology as a great new frontier for biological research. For the first time in world literature, an attempt is made in the book to summarize and evaluate the perspectives for the development of population biology on the whole. Examined are the main directions and methods of research used in the study of natural populations as distinct intraspecific groupings of individuals, as well as the practically important problems connected with a population approach to the exploitation of biological resources and to the preservation of living nature.

The book is primarily intended for students and specialists studying natural animal and plant populations, as well as for those concerned with conservation, and wildlife and forestry management.

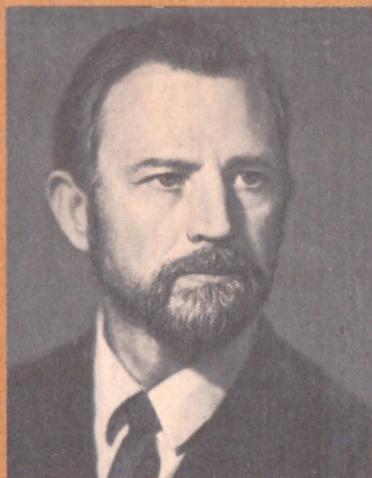


Victor V. Rodionov was born in 1910 in the village of Dedinov in the Moscow region.

Rodionov was first introduced to bees in early childhood, and before his ninth year he had already caught a swarm and settled it in a hive. From that time, bees have been his poetry, work, and life's purpose.

Rodionov received his solid knowledge of bees and beekeeping in the Gorsky Agricultural Institute and then in the Advanced Training Institute for Zootechnicians and Apiculturists.

His books enjoy wide popularity, including *Multiple-storey Hives and Methods of Bee Management* and *Methods of Modern Beekeeping*, all of which he coauthored with I. A. Shabarshov and which have been published in numerous editions and translated into many languages.



Ivan A. Shabarshov was born in 1922 in the village of Aleksandrovka in the Voronezh region. He was educated at Moscow State University, where he prepared for his scholarly pedagogical activities.

Beekeeping is a family hobby for Shabarshov. As early as the end of the last century, his grandmother, who was one of the first women beekeepers in Russia, began to raise bees in frame hives.

Shabarshov's interests include commercial and amateur beekeeping, the history of apicultural science, foreign apicultural practice.

The small apiary of the author serves as a form of recreation, a "field of experience", and a continuation of an old family tradition.